W. P. Hiern.
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THE GENUS DIOSPYROS IN CEYLON: ITS MORPHOLOGY, ANATOMY, AND TAXONOMY.

Part II.

By HERBERT WRIGHT.

(*With Plates I.–XX.*)

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The Genus Diospyros in Ceylon: its Morphology, Anatomy, and Taxonomy.

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HERBERT WRIGHT.

(With Plates I.–XX.)

Part II.

THE present contribution is the concluding portion of my paper, the first part of which was published in January, 1904. For local convenience the species are described in the same order as previously adopted in Trimen's Flora of Ceylon. A reference to Hiern's monograph for each species is also quoted. The synonyms for each species are not given since reference can always be made to those quoted in Hiern's comprehensive monograph on the Ebenaceæ.

In Part I. I explained that the flower systems were previously imperfectly known, and the descriptions given by Trimen and Hiern are frequently inadequate on account of the limited supply of fresh material which those botanists had at their command. In Trimen's Flora the staminal whorls of the male and female flowers, and often the accessory whorls, are not separately described.

In many species the flowers or fruits are not described in Trimen's Flora, but in several of these cases descriptions are obtainable from Hiern.

The male and female flowers, timbers, fruits, seeds, and seedlings have now been obtained for every Ceylon species except D. Moonii, and many of them are described here for the first time from material obtained in this Island.

The object has been to work out all details of our recognized species rather than to subdivide into varieties. Hence the question of the possibility of two species in D. montana, *Roxb.*, D. Embryopteris, *Pers.*, and D. Ebenum, *Koen.*, is only briefly dealt with. I am, however, unable to agree with the grouping of D. Thwaitesii, *Bedd.*, D. Moonii, *Thw.*, and D. hirsuta, *L.*, under one species—D. hirsuta, *Linn.*, as adopted in Hiern's monograph, and have, therefore, for reasons obvious in the descriptions of these species, adopted the separate classification used by Trimen.*

1. **D. ovalifolia,** R. Wight, Ic. t. 1,227 (1850).

Kunumella, Habara, S. ; Vedukkanari, T.

Thw. Enum. 181 (1864). C. P. 1825 (2,533). Fl. B. Ind. III., 557. Wight, Ic. t. 1,227 (1850). Hiern, Mon. Eben. 237.

A moderate-sized tree, diœcious ; bark with brown and pale alternating streaks ; becomes partly deciduous in the dry season in the Northern Province ; flowers in September and fruits in March. Leaves 35–130 mm. long, 6–50 mm. wide, alternate, accrescent and crowded, oval or lanceolate-oblong, obtuse or rounded at apex, narrowed at base, glabrous, thinly coriaceous, paler beneath with prominent venation ; *petiole* 3–7 mm. long.

Male inflorescence consists of sessile clusters of 3–7 flowers mainly on woody twigs ; bracts form a basal involucre. (See pl. XV., fig. 1.)

Flowers yellow, 5–10 mm. long ; they appear from September to December.

Calyx green, slightly hairy, and openly campanulate ; segments 4–5, apex rounded.

Corolla yellow, urceolate, glabrous or nearly so, 5–8 mm. long ; segments 4–5, obtuse apex, recurved when mature.

Stamens 13–20, paired, surrounding central rudimentary disc ; *filaments* unequal, about one-sixth the length of anthers ; *anthers* brown and glabrous.

* I have, since writing the above, received a communication from W. P. Hiern, Esq., in which that gentleman agrees with the separate classification here adopted.

Pistil rudimentary, apiculate, hairy.

Female flowers solitary or as sessile clusters of 3–9 flowers in axils of leaves or on woody twigs; buds pubescent, globular, surrounded by two or three small deciduous bracts. (See pl. XV., fig. 2.)

Calyx segments 4–5, brown or green, pubescent, 3 mm. long, rounded or bluntly acute at apex.

Corolla yellow, conical in bud, segments 4–5, shorter than tube.

Staminodes 1–7, usually 4, sometimes absent, hypogynous or at base of corolla.

Pistil green, pubescent; stigmas 2–4, green, reniform; ovary pubescent, conical, 4-celled (see pl. XV., figs. 4 and 5) *Fruit* globose, 2 cm. diameter, solitary, subsessile, 1–3–4,—usually 1-seeded, glabrous; fruiting calyx enlarged, thickened, reflexed. Fruits ripe in March.

Seeds hard, globose when solitary, wedge-shaped when numerous; testa brown and superficially striated, 7 mm. diameter, 9 mm. long; endosperm abundant, equable; embryo white, 5 mm. long. (See pl. XV., fig. 3.)

Seedlings epigeal; cotyledons detached early, testa does not split (*cf.* D. pruriens); *cotyledons* ovate, rounded base and apex, 4–6 mm. long; *hypocotyl* white or yellow, thin, 50–60 mm. long, 2 mm. diameter; *epicotyledonary* stem 8 mm. long; first epicotyledonary leaves form an opposite pair, ovate, hairy, 8 mm. long, 4 mm. wide; *traces* 2 per cotyledon which are not split to any great extent at the node and give a four-cornered appearance to the vascular cylinder in the hypocotyl, thus resembling D. montana and D. Ebenum; epicotyledonary traces one per leaf, conspicuous in the ungerminated embryo, particularly the phloem. In the apex of the primary root there are only eight strands, which may be the result of the splitting of four cotyledonary or may consist of two epicotyledonary and six cotyledonary strands.

Timber brown or dirty white or faint red in colour, inferior, sapwood and heartwood of very old trees possessing

a high per cent. of tracheal elements and small quantity of gum-resin. The heartwood is usually small and considerably decayed. The contents of the elements are scarce compared with the red or black woods of other species. Many specimens show thinly streaked heartwood, the black lines of which help to form a pretty pattern (*cf.* D. quæsita). (See pl. I., fig. 6.)

Uses.—Only the timber is used.

Distribution.—Common in dry region and intermediate zone, rare in moist region. Trincomalee, Anuradhapura, Kalugalla, Vavuniya, Madawachchi. Also in Madras and Anamalai hills.

2. **D. montana**, *Roxb.*, Cor. Pl., p. 37, t. 48 (1795).

Mulkarunkali, Katukanni, Vakkana, T.

Thw. Enum. 423. C. P. 1,909 (3,774). Hiern, Mon. Eben. 220. Fl. B. Ind. III., 555. Wight, Ic. t. 1,125.

A moderate-sized or small tree, diœcious, partially deciduous in the Northern Province; bark yellowish or silvery grey, smooth, shiny, thin, being 4–6 mm. in thickness, yellow when freshly cut; sharp spines on main stem, branches, and twigs, stumps of spines often characteristic of old trunk; flowers in September; fruits ripe in March–September; tree flowers when only 75 mm. diameter. Leaves 25–100 mm. long, 15–50 mm. wide, alternate, oval, oblong or lanceolate-oblong, obtuse or rounded apex, rounded or cordate at base, finely pubescent when young, glabrous when old, thin, yellowish-green, venation not pronounced; *petiole* 2–12 mm. long, finely pubescent. (See pl. XVI., fig. 7.)

The spiny character of the stem structures is said to be found only on one variety of this species, but it has been noticed on every plant reared at Peradeniya, even when only two years old.

Male inflorescence; Cymes 3-flowered or panicled in axils of small caducous bracts or young persistent foliage leaves. Main peduncle of inflorescence thin, green, 2–6 mm. long. Each lateral flower arises in the axil of a small narrow

bract 2 mm. in length, and is supported on a thin pedicel 2–5 mm. long. Primary and secondary pedicels show great variation in length. Flower-bud 4 mm. long, conical, apical, scentless; mature flower 8 mm. long and somewhat bell-shaped when segments recurved. (See pl. XVI., fig. 9.)

Calyx segments 4, rounded or deltoid, thin, pubescent, small.

Corolla, wide throated, segments 4, twisted at apex, urceolate, white or yellow.

Stamens numerous or 16, in equal or unequal pairs, often united to form 8 pairs; *anthers* brown, glabrous, apiculate, 2–4 mm. long; *filaments* white, glabrous, absent or 1 mm. long.

Ovary is a flattened rudimentary disc often of considerable size, which may yet be observed to develop into a ripe fruit; the polygamous condition will probably be found if a sufficient number of trees are examined.

The female flowers are usually solitary on woody twig or in axil of leaf (see pl. XVI., fig. 10); peduncle 4–12 mm. long, glabrous or pubescent; bracts small, caducous.

Calyx green, hairy, 10 mm. diameter; segments 4, 2–5 mm. long, rounded apex.

Corolla white or yellow, wide-throated, 11 mm. long, glabrous; segments 4, rotate.

Staminodes small, 4–12, usually 4.

Pistil green, glabrous or nearly so; styles 4, bifid at apex, glabrous; ovary glabrous, 8-celled.

Fruit globose-apiculate, 12–20 mm. diameter, 16 mm. high, glabrous and shiny, cherry-red to brown in colour; fruiting calyx thin, glabrous, accrescent or nearly horizontal, slightly enlarged, with segments 6–8 mm. long. (See pl. XVI., fig. 7.)

Seeds 2–6–8 per fruit, semilunar, wedge-shaped, brown, smooth, 8 mm. long, 4–5 mm. wide, 3 mm. thick; endosperm equable, copious; embryo white, small, 8–10 mm. long. (See pl. XVI., fig. 8.)

Seedlings epigeal; *cotyledons* persistent, ovate, tapering towards apex, green, glabrous, 30 × 15 mm.; petiole of

cotyledon flat, 2 × 2 mm.; *hypocotyl* green, cylindrical, faintly pubescent, 60 mm. long, 2 mm. diameter. The *epicotyledonary* system shows delayed development; leaves alternate, the first leaf occurs 3–8 mm. above the cotyledonary node, at right angles to the plane of the cotyledons, 30 mm. long × 9 mm. wide, green; the subsequent leaves arise in a spiral, and in size and form are similar to the first (*cf.* D. Ebenum and D. Gardneri for development).

Two *traces* per cotyledon; one trace to each epicotyledonary leaf; feeble splitting of cotyledonary xylem, epicotyledonary traces die out in hypocotyl.

Timber.—When freshly cut the wood is of a dirty white colour, but on exposure assumes a reddish tint. Black heartwood usually small, central part generally rotten. Some specimens show large heartwood not jet black, but often streaked (*cf.* D. affinis and D. oocarpa), and when such samples are sound the timber is equal to calamander in beauty. One specimen 30 cm. diameter, possessed a large heartwood consisting of a small black centre and a peripheral portion beautifully variegated in tints of brown and black. Most samples are inferior to ordinary ebony; the timber possesses a high per cent. number of parenchymatous and tracheal elements. (See pl. V., fig. 19.)

Uses.—Only the timber is used.

Distribution.—Common in dry zones, especially along the roadsides to Trincomalee and Mannar; characteristic of poor low-lying xerophytic forests. Jaffna, Matale, Trincomalee, Vavuniya, Puttalam, Mannar, Anuradhapura, Habarana, Kanthalai, Madawachchi. Also in India, Malaya, Burma, and Tropical Australia.

3. **Diospyros Embryopteris,** *Pers.*, Syn. 11, p 624, n. 6 (1807).

Timbiri, S.; Panichchai, T.

Thw. Enum. 178. C. P. 1,915. Fl. B. Ind. III, 556. Wight, Ic. t. 843, 844. Bedd. Fl. Sylv. t. 69. Bentl. and Trim. Med. Pl. t. 168. Hiern, Mon. Eben. 257.

A large tree, evergreen, diœcious, and polygamous ; trunk fluted when old, black, thick, and scaly, red when freshly cut; branches spreading, forming dense wide head, which in young trees is often conical in outline ; flowers March–July; ripe fruit, September–February.

Leaves 120–200 mm. long, 25–55 mm. wide, alternate, oblong or lanceolate-oblong, acute-lanceolate, acuminate or obtuse at apex, rounded or narrowed at base, glabrous except slight puberulence on petiole, thick and coriaceous, pale green colour, pellucid venation, veins prominent in dried leaves ; *petiole* thick, rigid, slightly pubescent, 5–13 mm. long.

The flowers of some male trees often show a central pistil possessing definite loculi, and which often assumes a very large size. Mature seeds from a polygamous tree have not yet been obtained.

Male inflorescence arises as a globular apiculate axillary structure, strongly pubescent, supported on short stout peduncles and surrounded by regularly arranged bracts, 3–7 flowers (see pl. IX., figs. 1–5) ; peduncle yellowish-white to green, 20 mm. long, 2 mm. diameter, covered with fine coating of silvery unicellular hairs ; pedicel of each lateral flower 4 mm. long ; bracts large, one to each flower, greenish-white, frilled or straight margin, broad base, acuminate apex, both sides pubescent, early deciduous, length 8–10 mm. ; bracteoles small, two on each pedicel arranged one on each side as an opposite pair at right angles to antero-posterior axis ; brownish-black, caducous, acuminate apex, 2 mm. long ; scar inconspicuous. *Flowers* 6 mm. long and ovoid in bud, when open 10–15 mm. long.

Calyx segments 4–5, accrescent, rounded or acuminate apex, 3–5 mm. long, greenish, covered with silky unicellular hairs on both sides, cup-shaped in mature flower.

Corolla segments 4–5, canary-yellow in colour, ovoid, 3 mm. long, rounded apices, inbricated sinistrorsely in bud, segments in open flower are erect or strongly curved outwards and downwards ; total length of corolla 8–13 mm., diameter

of open flower 10 mm.; corolla throat is wide and covered with silky unicellular hairs on both surfaces.

Stamens 24–30–40–64 (very unequal numbers), form epipetalous ring around abortive pistil or occupy central position; very unequal in length, often united throughout greater part of filament; usually in pairs, average length 8 mm.; *anthers* free, equal in length, reddish-brown rectangular outline when mature, glabrous, attenuate apex; *filaments* united, white, short, and covered on all surfaces with long unicellular hairs; *pollen* grains circular, even outline, brownish-yellow, finely granular contents.

Pistil usually occurs as a flattened circular central apiculate disc, or as a bunch of hairs positioned on the receptacle; in several cases the pistil assumes large dimensions with ovary many-celled.

Female inflorescence arises as globular structure in axil of normal foliage leaf, 1–5 flowers, subsessile or cymose; peduncle 10 mm. long, 4 mm. diameter, covered with yellowish-white hairs which rapidly turn to brownish-red; bracts usually 4, 10 mm. long, brown, bluntly acuminate apex covered with unicellular hairs; lower two form an opposite pair at right angles to antero-posterior axis, upper two are larger, and arranged one on each side at right angles to the first pair, but at different levels.

Flowers occur one in the axil of each bract, but the upper pair usually drop; very frequently the lower pair do the same, thus reducing the inflorescence to a peduncle showing four leaf scars along its length and terminated by the oldest and fruiting flower (*cf.* D. Gardneri). (See pl. IX., figs. 7–11.)

Flowers larger than in male and largest in Ceylon Diospyros group, measuring 20 mm. high, 30 mm. diameter when mature.

Calyx 3-4-5-lobed, accrescent in young flower, but becomes horizontal shortly after fertilization, and finally the marginsare recurved; segments ovate, tapering towards apex,

15 mm. long, 15 mm. wide at base, glabrescent or covered with long black unicellular hairs.

Corolla wide-throated, 3–4–5-lobed, yellow; segments broad, 18 mm. long, 10 mm. wide, apices recurved, apex rounded or sub-acute.

Staminodes 4, alternating with corolla segments, adnate to corolla tube, short, hairy; sometimes 1–12 in number, and may possess fertile anthers. (See pl. IX., fig. 12.)

Pistil globular-apiculate in bud, yellowish-green, and covered with multicellular glands borne on many-celled pedicels, forming a dense layer 1 mm. thick in bud; styles 4, hairy; stigmas lobed and undulated; ovary 8-celled, loculi in four pairs alternating with calyx segments, sometimes 6-celled in pentamerous and trimerous flowers; fruiting calyx deeply 4-lobed, enlarged, strongly reflexed margin, woody, hairy or glabrous; fruit usually solitary, subsessile or pedunculate, globular or ovoid, very large, 45 mm. high. The remnants of the multicellular glands, many of which are dead and changed to a brown or red colour, give the fruit a "rusty mealy" appearance; carpellary wall pulpy and rich in gum and tannin (*cf.* D. crumenata; D. quæsita). (See pl. IX., fig. 6.)

Seeds 4–8 per fruit, large, 15 mm. wide, 8 mm. thick, 25 mm. long; brown testa, elliptical-wedge shape; endosperm copious, white, equable; embryo white, large. (See pl. XVIII., fig. 7.)

Seedlings epigeal, *cotyledons* detached early in embryo and measure 16 × 9 mm., pale yellow, never green or assimilatory; hypocotyl 30–40 mm. long, yellow to green turning black; *epicotyledonary* system shows enhanced development; epicotyledonary stem 35–40 mm. long, 2 mm. diameter, red, pubescent; first epicotyledonary leaves form a subopposite or opposite pair and persist alone for some time and carry on the assimilatory work allotted to cotyledons; *traces* 3 per cotyledon, considerably split, continued into root.

Timber usually white with occasional black strands; sapwood always white when freshly felled, but on exposure turns faintly brown; black heartwood is very small even in

centre of very old trees; black strands occur irregularly in parts of the sapwood usually in association with wounds. This species attains a very large size in the wet and dry zones. The coloured contents of the elements are rarely abundant and the tree is therefore seldom felled with a view to obtaining ebony therefrom. Seasonal rings of growth are poor and irregular, but visible to the naked eye (see pl. V., fig. 20). Some specimens possess 85·1 per cent. of fibres; nevertheless the timber is very inferior to ebony, and is even less durable than red woods of other species.

Varieties.—Var. *atrata*, Thw. *l.c.* C. P. 2,731.

Leaves thinly coriaceous; buds, peduncles, and calyx densely covered with brown hairs.

Var. *nervosa*, Thw. *l.c.* C. P. 1,910.

Leaves very coriaceous, veins prominent on both sides, rounded at base; buds, peduncles, and calyx covered with black hairs; calyx segments enlarged, erect, and about as long as fruit.

Uses.—The fruit possesses a large quantity of gum and tannin, and the juice is used as a tan for fishing nets and for the planks of boats. The fruit and the bark both possess astringent properties and are used medicinally. The leaves are sometimes eaten as a vegetable. The timber is occasionally used for masts and yards for small boats.

Distribution.—Common in dry countries, especially along banks of streams, tanks, &c., invariably associated with Terminalia glabra in these localities; also occurs in the moist regions, particularly along streams, and associated with D. Moonii, *Thw.* Galle, Rayigam korale, Ratnapura, Ambalawa, Bibile, Viriniya, Bintenna, Hinidum, Vavuniya, Jaffna, Madawachchi, Hantane, Gangaruwa, Kadugannawa. Also in India and Malaya.

4. **Diospyros Toposia,** Hamilt. in Trans. Linn. Soc., Vol. XV., p. 115 (1827).

Kahakala, Kaluwella, S.; Vellei Thoverii, T.

Thw. Enum. 179. C. P. 1,911. Fl. B. Ind. III., 556. Hiern, Mon. Eben. 263.

A large or moderate-sized tree, diœcious, evergreen; branches glabrous, forming dense round head (*cf.* D. Embryopteris); bark thick, black, or dark grayish-brown. *Leaves* alternate, 75–300 mm. long, 25–80 mm. wide, acuminate apex, narrowed or rounded at base, glabrous, coriaceous, venation close, pellucid (*cf.* D. Ebenum), prominent when dry; midrib depressed on upper surface, green, paler on under surface; *petiole* stout, grooved, 5–12 mm. long, glabrous.

Flowers January–April–November; fruits ripe August–December.

Male inflorescence arises in axil of new or old normal foliage leaf or caducous bract. In the simplest case the cyme is 3-flowered, each lateral flower arising in the axil of a bract. The pedicel of each lateral flower bears a small bracteole (at an angle of 90° from the bract at the base of pedicel), which appears late and is positioned immediately beneath the calyx; bracts at base of peduncle green, pubescent, long tapering apex, prominent midrib, 7 mm. long and 2 mm. wide; bract at base of pedicel of each lateral flower is hood-shaped, has shortly tapering and acute apex, ventral surface pubescent, 2 mm. long and 2 mm. wide; bracteole on pedicel of each lateral flower is hood-shaped, ventral surface covered with short brown hairs, 1·5 mm. long, 1 mm. wide; primary peduncle green, covered with caducous or persistent brown hairs, 8–12 mm. long; lateral pedicels green, hairy, about 5 mm. long, and extending higher than median flower. (See pl. X., figs. 7 and 8.)

In a more complex inflorescence the lateral flowers arising on the long peduncle repeat the dichotomous structure detailed above; in cultivated specimens inflorescence 3–12-flowered.

Flowers yellow, globose-ovoid in bud, and measuring 8 mm. long, 5 mm. diameter; open flowers measure 11 mm. in length and 6 mm. in diameter, fragrant.

Calyx 2–3-lobed at apex, at first closed and may remain so, though ripe pollen grains formed within; segments thick, greenish-yellow, ventral surface pubescent.

Corolla yellow, urceolate, throat very narrow (*cf.* D. Embryopteris), and appears to be frequently closed; base 6 mm. diameter, apex 3 mm. diameter; segments 4, middle line pubescent on ventral surface, 0·8–1·5 mm. thick.

Stamens numerous and irregular, 18–24–33, yellowish-white, unequal length, hypogynous group or terminating receptacle; *anthers* 2 mm. long, not strongly apiculate, sometimes sessile, glabrous; *filaments* 2 mm. in length, white, glabrous, sometimes absent; *pollen* isodiametric, even outline, 2 mm. diameter, show one thin part in wall.

Pistil rudimentary disc or absent.

Female flowers solitary or cymose, occurring only on the lower part of young shoots in the axil of a bract or foliage leaf; bracts green to brown, caducous, small; pedicel green, covered with short adpressed hairs, 6–10 mm. long, 2 mm. diameter, widening towards flower.

A ringed scar is noticeable on the pedicel of each flower when solitary, which is probably the area of attachment of at least two bracts at an early stage, thus suggesting a cymose inflorescence with abortive lateral flowers. Such an inflorescence is shown in pl. X., fig. 9.

Flowers globose-apiculate in bud, with broad base, green, hairy, 5 mm. long; remain closed for a long time as in the male.

Calyx 4-lobed, segments deeply divided, tapering acute apex, green, both surfaces pubescent, dorsal surface silvery in appearance.

Corolla yellowish-white, tubular, urceolate; segments 4, short, and triangular-shaped, with acute apices.

Staminodes 12–16, usually as an epipetalous ring, short, white; anthers broad.

Pistil green, tetrahedral in bud and densely pubescent; style 0, stigmas 3–4, short; ovary 4–5–6-celled.

Fruit oblong or subglobose with wide base and flattened top, green, glandular, and covered with short thick-walled unicellular hairs, 40–60 mm. high, 30–40 mm. diameter; fruiting calyx enlarged, total diameter ·25 mm., flat; segments 10 mm. long, upper surface brown or green, rounded or oblong. (See pl. X., fig. 10.)

At Hiniduma there appears to be a variety having a globose-apiculate fruit about the size of ripe fruits in D. Ebenum or D. affinis.

Seeds 2–4 per fruit, oval or elliptical, or wedge-shaped; smooth brown testa, 25 mm. long, 10 mm. wide; endosperm copious, equable. Embryo white.

Seedlings epigeal, cotyledons detached early, epicotyledonary system not well developed, and in seedlings 50 mm. long, very minute; *hypocotyl* white, thick, rather short, 40–50 mm. long, suggesting affinity with D. insignis and D. dodecandra. Lour., Hiern Mon. p. 264 (1873). *Epicotyledonary* stem very long, 60–70 mm., longer than in any other species of Diospyros, suggesting D. insignis, except that it has no young leaves in the lower part; first epicotyledonary leaves form an opposite pair, but at different levels; 3 *traces* per cotyledon, 1 trace per epicotyledonary leaf; cotyledonary xylem splits to form 10–15 groups; epicotyledonary traces not well developed, and their courses are difficult to follow. (See pl. XVII., fig. 4.)

Timber red when freshly felled, deepening to reddish-brown on exposure. Black heartwood rarely of great size, usually numerous black strands irregularly distributed through the brown wood. This species is only rarely felled for the ebony it contains. (See pl. III., fig. 12.)

The tracheal elements contain abundance of a gummy deposit, yellow to brown in colour; contents in parenchyma are brown and granular. The per cent. number of tracheal elements is low and that of the fibres high; the differentiation of all the secondary elements is relatively constant.

Rings of growth are often conspicuous to naked eye.

Uses.—The ripe fruits are steeped in water and afterwards eaten by some natives. The timber of freshly felled trees

often yields large quantities of a gummy extract reputed to be efficacious for toothache.

Distribution.—Moist region only, 2,000 to 4,000 ft.; abundant along precipitous banks and rocky damp gullies as in Adam's Peak Wilderness and North-East Matale. Sinha Raja Forest, Hantane, Rakwana, Balangoda, Hewesse, Hinidum, Ambalawa, Gangaruwa, Kadugannawa, Pindeniya, Gammaduwa, Pitigala, Pettiagalakanda. Also in Eastern Bengal, Silhet, Khasia.

5. **Diospyros Ebenum,** Koenig in Physiogr. Salsk. Handl. I, p. 176 (1776).

Kaluwara, S ; Karunkali, T.

Linn. f. Suppl. Pl. 440 (1781). Retz. Obs. Bot. V, 31. Thw. Enum. 180. C. P. 1,912. Hiern, Mon. Eben. 208. Roxb. Fl. Ind. II., 529. Alph. DC. Prodr. VIII., p. 234 (1844). Bedd. Fl. Sylv. Madr. t. 65 (1870). Wight, Ic. t. 188 (1840).

A large evergreen tree, diœcious, polygamous, and occasionally monœcious, trunk erect and foliage dense ; bark thick, dark grey or black, occasionally scaly, finely grooved in branches and twigs, red when cut.

Leaves alternate, numerous, spreading dichotomously, very variable, 50–130 mm. long, 20–60 mm. wide, oblong-oval or oblong-lanceolate, acuminate, rounded or obtuse apex, usually narrowed at base, glabrous, thinly coriaceous, bright green and shining above, paler beneath, venation strongly reticulate and pellucid, and meshes wider than in D. Toposia. *Petiole* 4–8 mm. long, green, glabrous.

This species could be arranged to include several varieties according to variation in size, venation, and form of the mature leaves.

The monœcious state is rarely met with. I have seen it in the forests near Dambalagala Trigonometrical Station, Central Province, at an elevation of 1,900 feet, on rocky damp slopes. At this place one tree possessed the ordinary male flowers with indefinite connate stamens and rudimentary pistil, and female flowers each with 8 barren staminodes, typical calyx, and gynæcium. (See pl. XIII., fig. 5.)

The polygamous condition is much more common, and in some districts I have often experienced difficulty in finding a true male tree. When at Vavuniya with Mr. H. P. C. Armitage in April, 1902, every tree examined in the neighbouring village compounds possessed male and hermaphrodite flowers, and the extent to which polygamy existed reminded one of D. Gardneri, D. sylvatica, and D. affinis. (See pl. XII., fig. 4.)

The flower systems on the polygamous trees are dichasial cymes, and more often than not the median flower is hermaphrodite; sometimes the whole inflorescence consists of male flowers only. Hermaphrodite flowers are particularly abundant where there has been excessive production of flowers in a local area; perhaps this can be correlated, physiologically, with causes similar to those which determine the frequency as median or top flower of other cymes; certain it is that female flowers occur in areas where vegetative or floral construction is at the maximum.

Male inflorescence consists of a dichasial cyme of 3–15 flowers (*cf.* D. Toposia), sessile or subsessile on lower part of young shoots in axil of caducous bract of foliage leaf; bracts small, caducous, tapering apex, green, 2 mm. long. (See pl. XIII., fig. 1.)

Flowers.—The buds are linear, tapering, 10 mm. long and 2 mm. diameter.

Calyx funnel-shaped, green, 4 mm. long; segments 4, accrescent, green, speckled with white, rounded apex, short, nearly glabrous ventrally, hairy on dorsal surface, margins ciliate.

Corolla tubular, yellow, throat constricted, total length 11 mm.; segments 4 (rarely 3), glabrous, narrow, thick, rounded apex, rotate, 6 mm. long.

Stamens numerous, 20–30, usually 16, arranged in 8 epipetalous connate groups of 2's or 3's disposed opposite and alternate to corolla segments; one group of 4 consisted of a yellow pedicel 1 mm. long bearing 2 lateral sessile fertile anthers each 2 mm. long, immediately above this

point was a third anther disposed introrsely on a short filament, and above this, terminating the connate group, was the outermost and fourth anther, introrse, on a filament 2 mm. long.

One flower contained six groups of 4, and two groups of 2 stamens; the fusion of the filaments suggests a relationship to D. pruriens and D. Embryopteris; *anthers* white or brown, glabrous, apiculate; *filaments* glabrous, except near anther. (See pl. XIII., fig. 6.)

Pistil rudimentary, green flattened hairy disc.

Female flowers (see pl. XIII., figs. 2 and 3) are solitary, subsessile, in axil of foliage leaf or caducous bract; bracts 2, green, pubescent, forming on the short peduncle an opposite pair at right angles to antero-posterior axis.

Calyx green, cup-shaped, 3 mm. deep, with horizontal or descending segments; segments 3-4, 9 mm. long, acute apex, glabrous or nearly so.

Corolla yellowish-white, total length 15 mm., throat wide; segments 3–4, rotate, broad, 9 mm. long, rounded apex, recurved when mature.

Staminodes 8, flattened, epipetalous, opposite and alternate to corolla segments; *anthers* 1–5 mm. long, yellow or white deltoid, apiculate, hairy apex; *filaments* white, glabrous, broad base, 2 mm. long.

Pistil with green or yellow style; stigmas 4–5-lobed; ovary green, glabrous, 8-celled.

Fruit depressed, globose or subglobose, apiculate, glabrous, green; fruiting calyx forms an enlarged shallow woody cup lined with pedicellate glandular and also unicellular hairs; the margin becomes recurved and segments project outwards and downwards. (See pl. XIII., figs. 7 and 8.)

Seeds 2–8 in each fruit, flattened or wedge-elliptical in shape, 14 mm. long, 6 mm. wide, 3 mm. thick; testa brown or black; endosperm hard, copious, equable; embryo white, 5–6 mm. long. (See pl. XVIII., fig. 8.)

Seedlings epigeal, cotyledons persistent, epicotyledonary system delayed developmentally; *cotyledons* sessile or

subsessile, green, glabrous, ovate, tapering apex, broad base, size 26–38 mm. long, and 12–19 mm. wide, palisade tissue developed early; *hypocotyl* creamy-white, turning black, 50–60 mm. long. *Epicotyledonary* stem does not appear for several weeks or months after full exposure of cotyledons; when bearing three leaves it is about 15 mm. long.

The lowest epicotyledonary leaf is always very small, ovate, with broad apex; this serves to distinguish the young seedling from those of D. montana. The first pair of epicotyledonary leaves are at different levels but in the same plane, cutting that of the cotyledons at right angles; *traces* 2 per cotyledon, cotyledonary xylem may or may not become diffused; 1 trace per epicotyledonary leaf, which is not continued into the root.

Timber.—The wood from this species supplies the greater part of Ceylon ebony; that sold as bastard ebony may come from this species or from D. oocarpa, D. affinis, &c. D. Melanoxylon affords an equally good black heartwood. The ebony in the stem may increase from below upwards or may repeatedly increase and decrease in volume along the length of individual trees. Ebony has been noticed in saplings and in very small two year old twigs and even in roots.

The timber is jet black or streaked, very hard and heavy, and takes a good polish; the density is very high, and according to Hiern the seasoned wood weighs 81 lb. per cubic foot, and the unseasoned 90 to 100 lb. During the last five years no less than 2,635 tons have been sold in Colombo, realizing over £22,000.

The central black wood is usually obtained by cutting away the white sapwood. If the tree is allowed to lie on the ground for many months the white wood is removed by ants; occasionally wood borers eat into the hard black wood. As to yield of black heartwood per tree, Mr. Broun states that fifteen trees, varying in girth from 6 to 12 feet, gave a gross volume of 1,208 cubic feet, out of which only 282 cubic feet

consisted of ebony. The largest log seen by Mr. Broun measured 7 feet in circumference after the sapwood was removed. The proportion of black heartwood is said to increase on poor soils.

Rings of growth are inconspicuous, though in the sapwood a zoned structure of light and dark bands is presented. The area between any two narrow dark bands varies from 0·2–8 mm. radially. The dark band possesses fibres with thick walls and reduced radial diameters ; the wood parenchyma traverses these bands of thick-walled fibres without reduction in size ; the tracheal elements are equally abundant in the dark and light zones. (See pl. IV., fig. 16.)

There are not sufficient reliable data concerning the rates of growth of these trees. One tree at Peradeniya measured 147 mm. in circumference on 13th August, 1900 ; on 1st March, 1904, it measured 180 mm.; seedlings two years old may be 900–1,200 mm. high, and about 15 mm. diameter when grown in the open. Mr. Broun states that after passing 3 feet in girth they are very slow growing, and that probably a tree reaches a girth of 18 inches (4·57 metres) at 25 years, 26 inches at 75 years, 54 inches at 135 years, and 6 feet at the age of 200 years.

The anatomy and chemistry has been dealt with in the preceding part. (See pl. XIX., figs. 1–5.) p. 21.

Uses.—The timber is used in China for making chopsticks, pipes, and carved stands ; in Europe for turnery, cabinet work, piano keys, rulers, walking sticks, brushes, and general furniture.

The gummy astringent fruits are often eaten for their medicinal and feeding properties.

Distribution.—Chiefly in forests of dry and intermediate zones. In the moist zone it is rare and sporadic, extending up to 4,000 feet ; it is abundant in the Northern Province, especially north-east ; among many other places the following may be mentioned : Colombo, Pasdun korale, Hiniduma, Hantane, Deltota, Matale, Kandy, Hewesse, Dambalagala, Pindeniya, Gangaruwa, Kadugannawa,

Ambalawa, Passara, Bibile, Viriniya, Bintenna, Vavuniya, Trincomalee, Anuradhapura. Also in South India and Malaya.

6. **Diospyros pruriens,** Dalz. in Kew Journ. Bot., Vol. IV., p. 110, n. 2 (1852).

Bu-Kaluwara, S. (see below, p. 153.)

Thw. Enum. 423. C. P. 2,836. Hiern, Mon. Eben. 185. Fl. B. Ind. III., 553. Bedd. Ic. Pl. Ind. Or. t. 129.

A small drooping or erect tree with trunk rarely exceeding 1 foot circumference, evergreen, diœcious; branches and young twigs densely coated with long stiff brown hairs, 3–5 mm. in length; bark black, rather smooth, with narrow short ridges running longitudinally, reddish-brown when cut. Leaves not abundant, alternate, 50–100 mm. long, 15–45 mm. wide; obtusely acuminate apex, rounded or subcordate base, densely covered under surface with long yellowish-brown stiff hairs, especially on the veins, midrib, and margin, upper surface glabrous except along midrib, thin, not coriaceous, pale green below, venation widely reticulate and faintly pellucid, lateral veins not strong; *petiole* 2–5 mm. long, reddish-brown, covered with long stiff hairs. (See pl. XIII., fig 9.)

The male inflorescence arises in the axil of a foliage leaf, and consists of a raceme of 3–4 pedicellate flowers, the oldest being at the base and youngest at the top; primary peduncle is reddish-brown, covered with long stiff hairs, 10 mm. long, 1 mm. diameter, widening towards flowers; bracts subtending pedicel of each flower reddish-brown, rounded, very hairy on lower surface, caducous, 3 mm. long.

Flowers yellow, measuring 13–25 mm. in length. (See pl. XIII., fig. 9.)

Calyx green, 8 mm. long, 5 mm. diameter at base; segments 4, thin and papery, accrescent, linear-oblong, narrow at base, tapering acuminate apex, neutral surface covered with long yellowish-white hairs 5 mm. in length.

Corolla yellowish-white, 13–25 mm. long, 24 mm. top diameter when flower open, throat tubular, narrow inner surface hairy, ventral surface covered with long white hairs, 2·5 mm. diameter, but shows conspicuous basal swelling, segmental portion being much longer than tube; segments 4, rotate with basal part overlapping considerably, tapering acute apex, reddish-brown tint when mature, 13 mm. long, 6 mm. wide at base.

Stamens 12–14, forming hypogynous connate group terminating receptacle or surrounding hairy rudiment of ovary; in one case the connate base of andrœcium bore 7 separate stamens, each of which had a short white curved filament and gray anther opening introrsely by longitudinal slits, and measuring 1·5 mm. long; projecting above this was a yellowish-white pedicel 3 mm. long, which terminated in 5 sessile introrse anthers. The total length of this staminal system varies from 5–8 mm., and is the only one of its kind met with in Ceylon species. (See pl. XIII., fig. 10.)

Pistil absent or represented by rudimentary disc.

Female flowers yellow, solitary in upper axils of foliage leaves. Peduncle 16 mm. long, 12 mm. wide, covered with long stiff hairs, and often curved so as to place the flower with stigma pointed downwards.

Calyx green, accrescent in flower; segments 4–5, oblong, tapering acute apex, 8 mm. long, 3 mm. wide at base, ventral surface covered with long white hairs, dorsal surface rather shiny and subglabrous.

Corolla yellow, tubular, constricted towards middle, 10–28 mm. long; segments 4–5.

Staminodes 5 or more, epipetalous, linear; anthers and filament glabrous.

Pistil greenish-yellow, densely coated with long white hairs, styles 2, separate, 4 mm. long, stigmas 4, yellow; ovary depressed, globose, 4-celled, 5 mm. diameter.

Fruit solitary, globose, strongly apiculate, 20 mm. diameter, 25 mm. high, greenish-yellow, covered with long white hairs said to sting, wall thin and shrinks considerably

a few hours after fruits collected; fruiting calyx only slightly enlarged, segments inclined or nearly horizonal, thin, no cup formed, 11 mm. length, 4 mm. wide at base. (See pl. XIII., fig. 11.)

Seeds 1-4 per fruit, elliptical-wedge to globose-ovoid in shape; testa reddish-brown, smooth, 16 mm. long, 10 mm. wide, 10 mm. thick; endosperm equable and under great pressure in young fruits; embryo white, 6-10 mm. long. (See pl. XIII., fig. 12.)

Seedlings epigeal, cotyledons detached early, epicotyledonary leaves enhanced developmentally, testa does not split (*cf.* D. ovalifolia); *cotyledons* white, glabrous, square base, rounded apex, prior to detachment measure 11 mm. long, 8 mm wide; *hypocotyl* reddish and densely covered with long white hairs (very characteristic), 70-80 mm. long, 5 mm. diameter; *epicotyledonary stem* red, 10 mm. long, first two epicotyledonary leaves form opposite pair; *traces* 3 per cotyledon, xylem of median trace equal or stronger than either lateral, diffused in lower part of hypocotyl; epicotyledonary traces 1 per leaf, weak, continued into root, but not into apical parts. (See pl. XVIII., figs. 1-5.)

Timber never black, but white tinged with yellow when freshly cut, on exposure turns red; heavy, compact; elements partially filled with reddish-brown deposit, low per cent. number of tracheal elements, and 78·30 to 80·99 per cent. fibres. The small size of trees of this species renders the extraction of the coloured wood, when present, unprofitable. (See pl. I., fig. 1.) The hairs on the twigs and fruits are said to possess stinging properties. F. Lewis, Esq., suggested the appropriate native name for this species.

Distribution limited to our wet zone, Southern Province and South-Western Province, up to 2,000 feet. This is one of our very rare species. Thwaites collected the vegetative organs only. Trimen did not see either flowers or fruits of this species. In the forests of Gilimale, Sinha Raja, Marakelle, Idikada-Mukalana, and Koskandahena the plant occurs as a sparsely foliated bushy tree, 900-1,500 mm.

high, and often a single plant is of a size convenient for a herbarium specimen. Owing to the kindness and assistance of F. Lewis, Esq., Assistant Conservator of Forests, I was able to make a tour through the Peak Wilderness, where this species proved to be very abundant in local areas. In the vicinity of Magala, Kadawatta, and Eratna, on rocky sandy soils and along precipitous streams, this species attains a height of 6,000–9,000 mm. (20–30 feet) and a circumference of about 300 mm. (1 foot). It has also been found in the Marakelle forest, Kuruwiti korale (Lewis). Also occurs in Bombay and Mysore.

7. **Diospyros attenuata,** Thw. Enum. Cey. Pl., p. 182, n. 18 (1860).

Kadumberiya, S.

Thw. Enum. 182 (1860). Fl. B. Ind. III., 561. C. P. 3,478. Bedd. Ic. Fl. Ind. Or. t. 139. Hiern, Mon. Eben. 182.

A small tree rarely exceeding 1½ feet in circumference and 20 feet in height, bearing flowers when trunk one inch (25 mm.) diameter ; forms a mat of roots at the base ; evergreen, diœcious ; young shoots sparingly puberulous, quickly glabrescent ; bark black, not scaly, red when freshly cut ; branches and foliage present a weeping habit, branches given off low down.

Leaves (*cf.* D. Thwaitesii) alternate, 50–115 mm. long, 12–30 mm. wide, narrowly ovate or oblong-lanceolate, acuminate apex, narrowed or acute at base, young leaves glabrous except on under side of midrib, thin, reddish when young, green when mature, venation reticulate, feebly pellucid in young leaf, but opaque in old leaves, lateral veins fine but more conspicuous in old leaves ; *petiole* green, glabrous, 2–4 mm. long. (See plate XI., fig. 15.)

Flowers and ripe fruits September to December.

Male inflorescence consists of a sessile cluster of 3–25 very small narrow flowers borne in axil of leaf or on old twigs ; the same plant may bear flowers in successive years. Each flower is in the axil of a very small bract covered externally

with black hairs ; only rarely are the flowers solitary. (See pl. XI., figs. 10 and 11.)

Flowers long and narrow in bud measuring 9 mm. long and 1·5 mm. diameter, smallest flower among Ceylon species of Diospyros, dirty yellow in colour, usually turned downwards, and easily detached.

Calyx small, dark brown, pubescent, 2 mm. long; segments 4–5, deltoid, acuminate apex, 0·9 mm. long, densely coated with dark hairs.

Corolla small, dirty white, diameter of open flower 5 mm., diameter at base 2 mm., covered externally with dark adpressed hairs ; segments 4–5, acuminate, rotate, subglabrous inside, 2 mm. long.

Stamens epipetalous, 4–6, unequal in length, glabrous (4–5 in one row, Hiern) ; *anthers* yellow, 1·6 mm. long, tapering apex, occasionally apiculate ; *filaments* white, 0·3–1·2 mm. long ; *pollen* greenish-yellow, thin smooth wall, circular, coarsely granular contents.

Pistil rudimentary or as central flat hairy disc.

Female flowers sessile and solitary in leaf axil ; in bud four-sided, pyramidical, 7 mm. long, dirty yellow in colour; when open measures 10 mm. in length, average diameter 5 mm. (See pl. XI., fig. 14.)

Calyx segments 3–4–5, accrescent, brown, feeble intersegmental groove and reflexed margin, deeply divided, deltoid, thinly covered with black stiff hairs, 6 mm. long.

Corolla dirty yellow when fresh, red when about to drop; projects 3–4 mm. above calyx ; segments 3–4–5, rotate, with under surface of exposed halves densely pubescent, tapering acute apex, 4 mm. long.

Staminodes 4–5, epipetalous, alternate with corolla segments ; *anthers* yellowish-brown, barren, glabrous, 1·2 mm. long ; *filaments* yellowish-white, glabrous, 2 mm. long.

Pistil yellow and covered with stiff black accrescent hairs; 6 mm. long in mature flower ; style short, stigmas 2, black, short, each about 1·1 mm. long ; ovary pear-shaped, densely pubescent, 4-celled, 3 mm. in length.

Fruit ovoid-apiculate having a basal diameter of 22 mm. narrowing sharply in the upper part, then tapering gradually to an acute apex ; total length 35 mm. ; wall light green in colour, hairs short and sparse ; calyx of fruit enlarged to total diameter of only 16 mm., not accrescent, deeply lobed thin, green, hairy. (See pl. XI., fig. 13.)

Seeds 2–3–4 per fruit ; 25 mm. long, 10 mm. wide, 5 mm. thick ; elliptical-wedge or semilunar shape ; testa umber brown, smooth ; endosperm copious, equable. (See pl. XI., fig. 12.)

Seedlings epigeal, cotyledons detached early, epicotyledonary leaves enhanced developmentally. *Cotyledons* pale colour, ovate ; *hypocotyl* white turning black, 75–80 mm. long, 3 mm. diameter ; *epicotyledonary* stem 20–25 mm. long; first epicotyledonary leaves form an opposite pair, leaves being broadly ovate with tapering apex, rounded base, venation reticulate and feebly pellucid, length 40–45 mm., and width 25–30 mm. ; *traces* 3 per cotyledon, xylem diffuse, epicotyledonary traces 1 per leaf.

Timber red with small black decaying heartwood, heavy, very compact fine grain ; the smallness of the tree, maximum diameter being about 160 mm. (6–6½ inches), renders it impossible for most commercial purposes ; tracheal elements are narrow but irregularly differentiated, fibres abundant. The medullary rays and vessels have characteristic large lumina. (See pl. III., fig. 10.)

The coloured materials are absent from the fibres, but are moderately abundant in the medullary ray cells and vessels. The wide pits between adjacent medullary ray cells possessing coloured materials are often completely choked with the coloured material, suggesting the passage of these substances in solution from cell to cell.

Distribution.—This is one of our very rare endemic species, being limited to the wet forests in the south of the Island. It occurs as a very small tree along river sides in the damp forests of Wewella, Pasdun korale, about eight miles north-west of Hinidumkanda. It has also been found at

Hewessa, but nowhere else. It grows in rich clayey soil, and often accompanies D. acuta. When not in flower or fruit it is very difficult to distinguish from small trees of D. Thwaitesii.

Trees with trunks only 25 mm. diameter bear flowers and fruits. Solitary trees are rarely met with in some forests, there being a tendency for them to occur in clumps of 1–7; this must be due to some difficulty in transference of seeds; the seeds come up very freely in the forest, the primary root forming a straight axis which pierces the attenuate apex of the fruit and soon establishes itself.

8. **Diospyros acuta,** Thw. Enum. Ceyl. Pl., p. 182, n. 17 (1860).

Thw. Enum. 182. C. P. 3,476. Fl. B. Ind. III., 561. Hiern, Mon. Eben. 182.

A small tree, largest measuring 102 mm. diameter (4 inches) and height 10·6 metres (35 feet), flowers when only 25–75 mm. diameter, evergreen, monœcious only; bark black, when freshly cut is red in colour. *Leaves* alternate, 120–250 mm. long. 30–70 mm. wide, narrowly lanceolate-oblong, tapering gradually to an obtuse or acute apex, narrowing at base, glabrous, very thick, deep green above, pale green below; venation reticulate but only feebly pellucid, lateral veins never project on either side; *petiole* stout, slightly channelled above, 25 mm. long; when not in flower or fruit very difficult to distinguish from D. Moonii. Flowers and fruits September to December.

The sex is only met with in the monœcious state; the clusters in the axil of a particular leaf usually possess all male or all female flowers; the female clusters seem characteristic of the younger leaves towards the end of the twigs (*cf.* D. Ebenum; D. oppositifolia).

Thwaites remarks that the flowers are sometimes monœcious, female above, male below.

The male inflorescence consists of sessile clusters of 1–7 flowers. The bract subtending each flower is green, caducous, pubescent with tapering apex, 5 mm. wide at base

and 7 mm. in length. The flowers are yellowish, 14 mm. long, average diameter in bud 3 mm., diameter of open flower 10 mm. (See pl. VII., figs. 8 and 9.)

Calyx brown, densely pubescent, 7 mm. long ; segments 4–5, accrescent, acute apex, 4 mm. long.

Corolla yellow, segments and throat covered with yellowish-brown hairs, 16 mm. long when open; segments 4–5, rotate, very hairy on half of under surface, tapering acuminate apex, 4 mm. long.

Stamens 5–7–9, epipetalous, glabrous, separate or united in pairs, unequal in length ; often the inner stamen of a pair is very small and contains very little pollen; *anthers* yellowish-brown, apiculate, 3 mm. long; *filaments* white, 2 mm. long ; *pollen* circular, yellowish-green, thick-walled, granular contents.

Pistil absent or rudiment of unicellular hairs terminating receptacle.

The female inflorescence is sessile and usually consists of 1–3 flowers ; when solitary a pair of opposite bracts is easily seen; when there is a sessile cyme of three flowers, it is difficult to determine the position of the bracts, which are very early caducous ; bracts larger than in male, covered with brown hairs. (See pl. VII., figs. 10–12.)

Flowers large and in bud measure 15 mm. long, 5 mm. diameter.

Calyx large, 12 mm. long, brown, both surfaces densely pubescent; segments 5–6, lanceolate, tapering acute apex, accrescent, small intersegmental groove, margins straight, 8 mm. long.

Corolla yellow, large, 18 mm. long, diameter at base 6 mm., diameter of open flower 14 mm., outer surface pubescent ; segments 5–6, rotate, reflexed, hairy beneath, subglabrous above, tapering apex, base 5·5 mm. wide, length 5·5 mm.

Staminodes 5, epipetalous, alternate with corolla segments ; *anthers* yellow or brown ; *filaments* white.

Pistil large, 13 mm. long ; stigmas 2–3, reddish-brown, spathulate, glabrous, and 1·5 mm. long; style densely pubescent, 4 mm. long ; ovary globular, apiculate, brown, densely pubescent, 4-6-celled. (See pl. VII., fig. 14.)

Fruit ovoid-attenuate, tapering strongly towards stigmas, 30 mm. long, 15 mm. diameter ; fruiting calyx enlarged, segments 15 mm. long, intersegmental groove and reflexed margin pronounced. (See pl. VII., fig. 13.)

Seeds 4–6 per fruit, flattened-elliptical, strongly acuminate at micropylar end, 22 mm. long, 7 mm. diameter ; testa umber-brown, smooth and shiny, endosperm copious, equable ; embryo white, 12 mm. long.

Seedlings epigeal, cotyledons detached early, 3 traces per cotyledon.

Timber when freshly cut is dirty white, but on exposure turns red ; small trunk, no black heartwood, heavy, compact.

The narrow lumined fibres form 88 per cent. of the elements in many parts, and the rings of growth are very inconspicuous.

The elements are never abundantly supplied with contents, the majority being not more than quarter filled ; in the sapwood the contents are always yellow and in the form of globules ; in the heartwood they are of a deeper colour, occasionally granular, but never abundant. (See pl. III., fig. 11.)

Uses.—Only the timber is used.

Distribution.—This is a very rare endemic species found with D. attenuata in the Wewella, Wirakanda, and Hewessa forests, Pasdun korale. It has not been found outside this very wet area.

The trees usually vary from 4 to 6 metres (20 to 30 feet) in height and 25–75 mm. in diameter, the maximum size being quoted above ; they thrive best in clayey or boggy patches and like D. attenuata frequently occur in clumps of 3–14 trees, the leaders being matted together by dense woody roots at the base. The leaves and large stems are very similar, microscopically, to D. Moonii.

Diospyros Gardneri, Thw. Enum. Ceyl. Pl., p. 181, n. 12 (1860).

Kadumberiya, Kallu, S.

Thw. Enum. 181. C. P. 1908. Fl. B. Ind. III., 561. Bedd. Ic. Fl. Ind. Or. t. 132. Hiern, Mon. Eben. 182.

A moderate-sized or large tree, evergreen, diœcious and polygamous; branches glabrous, young twigs pubescent; bark black, thick, when freshly cut yellowish-red. *Leaves* very variable in size and form, alternate, 75–180 mm. long, 25–55 mm. wide, oblong or oval-lanceolate, acuminate apex, narrowed at base, glabrous and shining, thinly coriaceous, deep green above, paler green beneath, venation reticulate, pellucid, bullate, lateral veins prominent beneath; *petiole* 7–25 mm. long, slightly pubescent below.

The peduncle is usually curved so as to bring the flowers directed downwards, in which case they are partially protected from sun, wind, and rain by the leaves.

Sex.—Some trees are male only, others female only, and others polygamous; several of the latter group are growing at Peradeniya.

The polygamous condition may be observed on many trees growing at Peradeniya, and has been determined for three years in succession; the flowers on polygamous trees may be grouped as follows: (*a*) those with short accrescent calyx segments, fertile anthers, and abortive apiculate pistil; (*b*) those with large deltoid calyx segments, margins of which are straight or recurved, fertile anthers, and abortive apiculate pistil; (*c*) those with large deltoid calyx segments with deep intersegmental grooves, fertile anthers, and fertile pistil producing seeds. Hence the series from male to hermaphrodite flowers on the same tree is gradual and complete. (See pl. XII., figs. 1–8.)

The accessory whorls exhibit very few external characters which enable one to distinguish the male from hermaphrodite flowers. The enlarged recurved calyx segments are the best external indications of a hermaphrodite flower, but

these characters may be absent in such flowers, or may be occasionally present in male flowers.

The development and anatomy of the seedlings was originally studied from seeds obtained from the polygamous trees.

The male and hermaphrodite flowers occur separately or as members of the same axillary inflorescence (*cf.* D. sylvatica and D. Ebenum).

Male inflorescence consists of sessile and subsessile pubescent cymes; developmentally it first appears as a red pubescent bud in the axil of a leaf with or without a peduncle; on either side at right angles to the antero-posterior axis a bract appears, each subsequently bearing a flower in its axil. After a long interval another pair of opposite bracts appear in a plane at right angles to the first, followed by a flower in the axil of each. The primary flower occupying the centre of the inflorescence may be subsessile or supported on a peduncle 10 mm. in length, but each subsequent flower is always sessile. Further complications follow in consequence of the development of pairs of flowers around each of the subsequent flowers mentioned above. Peduncle 1–2–10 mm. long, green, pubescent; bracts small, 2·5 mm. long, 2 mm. wide, caducous, tapering apex, pubescent. (See pl. XII., fig. 5.)

Calyx green, ventral surface pubescent, 5 mm. long; segments 4, 3 mm. long, accrescent, deltoid, acuminate apex, straight or slightly recurved margin.

Corolla yellow, conical in bud, 10–13 mm. long, tube inflated; segments 4, half the length of tube, spreading, glabrous inside, silky pubescence outside.

Stamens 12–16, epipetalous or monadelphous hypogynous group, separate or connate in pairs, inner series always shorter than outer; when 12 only they are usually as 4 pairs and 4 singles, the former being divisible into an outer and inner series; *anthers* inner series 3 mm. long, apiculate.

glabrous or slightly pubescent, 1–5 mm. long; *pollen* yellow, even circular outline. (See pl. XII., figs. 9 and 10.)

Pistil absent or represented by a flattened apiculate disc which often shows in transverse section a crude celled structure.

Female flowers are solitary in axil of leaves, sessile or subsessile; peduncle 4 mm. long, and possesses two pairs of bracts which never bear flowers in their axils, but from comparison one may perceive a similarity with a cymose inflorescence in which all except the primary flower abort (*cf.* D. Embryopteris); first pair of bracts brown, near base of peduncle and at right angles to antero-posterior axis; second pair green, hairy, and at right angles to the first. (See pl. XII., figs. 11 and 12.)

Calyx green, openly campanulate, pubescent; segments 3–4, usually 4, 10 mm. long, deltoid, margin recurved and undulated so as to form a ridge, 2 mm. wide, projecting outwards and downwards, tapering apex.

Corolla white or yellow, tube 8 mm. wide, when mature 15 mm. long and 10 mm. diameter at top, silky pubescent beneath; segments 3–4, 7–10 mm. long, 2 mm. wide, strongly reflexed or spreading in open flower.

Staminodes 8, epipetalous, opposite and alternate with corolla segments, 5 mm. long, 0·5 mm. wide; *filaments* white, hairy, 3 mm. long, adnate to corolla tube at base; *anthers* white, barren. (See pl. XII., fig. 13.)

Pistil with stigmas 3–4, greenish-white; style persistent, 5 mm. long; ovary globose-apiculate, pubescent, 8-celled.

Fruit solitary, green, nearly glabrous, depressed-globose, apiculate, yellow when ripe, 35 mm. high, 25 mm. diameter; fruiting calyx enlarged and hemispherical, deep undulating intersegmental grooves, cup for fruit 15 mm. deep. *Seeds* usually 8 per fruit, thin and flattened, micropylar end slightly recurved, antipolar end straight or rounded, 15–18 mm. long, 8–10 mm. wide, 2 mm. thick; testa olive-brown, shining, not streaked; endosperm copious and equable; embryo white and measures 17 mm. in length.

Seedlings epigeal, cotyledons persistent, epicotyledonary system late in development; *cotyledons* pale green, 40 mm. long, 20–30 mm. broad, cordate, tapering apex, rounded base; *hypocotyl* erect, 90 mm. long, 2–3 mm. diameter, glabrous, becomes black and four-cornered; *epicotyledonary* system does not appear until several weeks or months after cotyledons fully developed; *epicotyledonary* leaves are alternate and measure 25 mm. long, 12 mm. wide, glabrous, deep green, coarse bullate venation; 2 *traces* to each cotyledon, xylem split considerably; epicotyledonary traces 1 per leaf, not continued into root.

Timber yellow with occasional black strands, inferior; similar to D. sylvatica; wood parenchyma wide lumined, tracheal elements rather low percentage number; large radial strands of parenchyma occur in the wood (*cf.* D. quæsita); the coloured contents are not abundant; timber used for buildings. The wide lumined parenchyma and the sparse contents of the secondary xylem elements prove the timber to be of inferior quality. (See pl. II., fig 7.)

Distribution limited to wet and intermediate zones of Ceylon, up to 2,500 feet; Colombo, Ratnapura, Kurunegala, Hantane, Gangaruwa, Ambalawa, Karawita, Sinha Raja forest, Pindeniya, Eratne, Gammaduwa.

10· **Diospyros oocarpa,** Thw. Enum. Ceyl. Pl., p. 180, n. 9 (1860).

Kalu kadumberiya, Eta timbiri, S.; Vellai karunkali, T.

Thw. Enum. 180. C. P. 1,914.

Fl. B. Ind. III., 560. Hiern, Mon. Eben. 171.

A moderate-sized or large tree, evergreen, diœcious; bark thick, dark surface, yellowish when cut, young shoots faintly pubescent; flowers in April, fruits in September.

Leaves alternate, 50–90 mm. long, 25–50 mm. wide, ovate or oval, obtusely acuminate at apex, rounded at base, glabrous and shining, thinly coriaceous; venation widely reticulate and faintly pellucid, but inconspicuous in old leaves; *petiole* flat, 5 mm. long. (See pl. VII., fig. 7.)

Male inflorescence consists of an axillary dense sessile or sub-sessile cyme, each flower being subtended by a concave rounded bract.

Flowers bomb-shaped, tapering from base to apex and measuring 12 to 25 mm. when unopened. (See pl. VII., fig. 1–3.)

Calyx green, faintly pubescent, forming a cupule 5 mm. high and 4 mm. diameter ; segments indistinct with margins forming an even outlined rim.

Corolla yellow, throat narrow, 13 mm. long ; segments usually 3, long and tapering, 6 mm. long, reflexed when flower mature. One of the segments is completely enclosed by the others in bud, the other lobes imbricating sometimes dextrorsely and at other times sinistrorsely (Hiern).

Stamens indefinite, 9–11–12–14, epipetalous or hypogynous, unequal, not apiculate, in pairs or single ; *anthers* brown, hairy, 1 mm. long ; *filaments* white, glabrous, 0·5–2 mm. long ; *pollen* yellow, circular.

Pistil represented by rudimentary hairy disc or absent.

Female inflorescence consists of sessile cluster of 3 flowers ; sometimes the flowers are solitary ; bracts very small and caducous. (See pl. VII., fig. 4.)

Flowers bomb-shaped when young, 12 mm. long, 4 mm. in diameter.

Calyx brownish-black, thin, glabrous or feebly hairy, forming a cupule 5–7 mm. high ; segments indistinct, agreeing with male calyx ; calyx of quite specific type.

Corolla greenish-yellow, tapering to apex, 15 mm. long ; often closed ; segments 3, not very distinct, short, walls very thick.

Staminodes 3, epipetalous, very short, total length being 0·5 mm. ; *anther* barren, brown or yellow, hairy towards apex ; *filament* white, glabrous and about one-third the length of anther.

Pistil brown, hairy, small ; stigma single or bifid, short ; ovary 6-celled.

Fruit oblong-ovoid, 35 mm. high, 23 mm. average diameter, wider at the top than towards calyx, rounded at top, apiculate; carpellary wall green, glabrous, uneven surface first being papillate and finally strongly lobulate, the lobes being conspicuous in one seeded fruits; usually 4–6-celled, one seeded; fruiting calyx slightly enlarged, flat, circular, total diameter 11 mm., persistent, glabrous, black. (See pl. VII., fig. 5.)

Seeds flattened, elliptical, with two longitudinal grooves running along the surface, or tending to become as broad as long with a beaked micropyle and as many as five deep longitudinal grooves; form different from all other species; average length 25 mm., width 15 mm.; testa brown, shiny; endosperm copious, horny, equable; embryo white, 11 mm. long.

Seedlings epigeal, cotyledons detached early, epicotyledonary leaves slightly enhanced developmentally; *cotyledons* narrow, yellow, 12 by 4 mm.; *hypocotyl* short type, 10–30 mm. long, 2·5 mm. diameter, at first white, but soon turns brown and black; epicotyledonary stem long, slender type bearing several small leaves along its length at intervals of about 10-20 mm.; at a distance of about 40 mm. the large leaves are borne alternately; stem greenish, densely pubescent; epicotyledonary leaves lanceolate-ovate, even surface, glabrous above except along midrib, pubescent beneath, venation faintly pellucid; veins not prominent on either side, widely reticulate, petiole short; *traces* three per cotyledon, xylem splits into 8–13 strands; one trace per epicotyledonary leaf, continued below cotyledonary node.

Developmentally and morphologically these seedlings are, in many respects, like those of D. insignis. The epicotyledonary leaf rudiments suggest Garcinia.

The timber is very variable. The young trees have usually a small black or brown heartwood, and a sapwood of a faint red tint; large trees possess a coloured heartwood of considerable size; one tree having a total diameter of

690 mm. had a heartwood 440 mm. diameter. The heartwood of such trees is invariably irregular in outline and presents a beautiful alternation of black and brown layers, which from an ornamental point of view greatly enhances the value of the timber; such specimens are almost equal to calamander for ornamental purposes. The sapwood of large trees may possess irregular dark lines, which in longitudinal section give good patterns to the coloured timber. The coloured materials occur in all elements of the sapwood except the fibres. The contents of the parenchyma cells is at first granular, but when these granules have disappeared the coloured contents take on the appearance of a gum-resin. In the heartwood all the elements, fibres included, become filled with brown or black contents, with or without a change in the colour of the walls of the elements. The only clear lines in a transverse section of the black heartwood are those of the medullary rays, the comparative clearness of this tissue being due to the thinness of their walls and the partial exhaustion of contents.

Anatomically the timber is characterized by abundance of closely set fibres, and large tracheal elements, and a low percentage number of medullary ray cells. The differentiation is very irregular. Rings of growth are very inconspicuous.

The timber of this tree is rarely met with, and may in some cases furnish the bastard ebony of commerce. (See pl. IV., fig. 15.)

Distribution rare in the dry and intermediate zones; Haragama, Uma-oya, Kurunegala, between Nalanda and Dambulla, Maturata, Kalugalla, Mihintale.

Also in Konkan and Babaloodun hills, Mysore.

11. **Diospyros quæsita,** Thw. Enum. Ceyl. Pl., p. 179., n. 7 (1860).

Kalumediriya, S., Calamander.

Thw. Enum. 179. C.P. 3,010. Fl. B. Ind. III., 560. Bedd. Ic. Pl. Ind. Or. Pt. VII., p. 26, t. 128 (1871). Hiern, Mon. Eben. 174.

A large slow-growing evergreen tree, diœcious; trunk erect and feebly buttressed; branches dark and spreading; bark blackish-gray, 12 to 20 mm. thick in very old trees, peels off in thin sheets exposing brownish layer beneath; bark of twigs shows irregular, narrow, longitudinal ridges; young twigs stout, green, glabrous.

Leaves alternate, 75–180 mm. long, 40–80 mm. wide, oblong-oval, or oblong-lanceolate, shortly acuminate obtuse apex, glabrous, coriaceous; venation feebly pellucid in young leaves, lateral veins inconspicuous, nearly horizontal, prominent when dry; *petiole* 12–20 mm. long, stout, flattened, and canaliculate above.

Male inflorescence occurs in axil of foliage leaf or small caducous bract; in former case there is often congenital concrescence of peduncle and stem for a distance of several mm.; flowers 3–9 on drooping pedicels along the length of primary peduncle at very irregular distances, the first flower occurring at the base or 20 mm. above the base; primary peduncle green, stout, very variable length; each flower is pedicellate and subtended by a caducous bracteole. Each pedicel bears an opposite pair of small bracteoles; pedicels green, slightly pubescent, wide towards flower, 6 mm. long, 1·5 mm. diameter; bracteole subtending pedicel green, pubescent, sessile, tapering obtuse apex, rounded base, caducous, 8 mm. long, 2 mm. wide; basal bracteole and axis green, covered with long unicellular hairs, lanceolate, tapering apex, 4 mm. long, early caducous leaving small scar. Hence there appears to be an inflorescence, which though now approximating to a raceme, possesses the rudiments of a dichasial cyme. (See pl. VI., fig. 7).

The flowers are often closed when the mature pollen is ready for dispersion; the diameter of open throat is small (*cf.* D. Toposia).

Calyx green, forms deep cup for floral parts and in bud is elongate-oval, 9 mm. long, 4 mm. diameter; segments pubescent, deltoid, acute apex.

Corolla yellow, tubular, thick, narrow-throated, basal part swollen, 12 mm. long; segments 4–5, rotate, pubescent beneath, broadly ovate, sub-acute apex.

Stamens indefinite, or about 16, terminating receptacle, 3 mm. long; *anthers* yellowish-brown, nearly sessile, attenuate and pubescent apex; *filaments* white, short, glabrous; *pollen* thin-walled, yellowish-white, feebly granular contents.

Pistil absent or rudimentary.

Female flowers.—My first fresh material was obtained through the kindness of F. Lewis, Esq., from Nahitimukalana, Atakalan korale, 1,800 feet above sea level.

Flowers solitary, pedunculate in axil of foliage leaf, or on lower part of young shoots in axil of caducous bracts; in bud 5 mm. long, 8 mm. diameter, resembling in appearance those of D. Melanoxylon. Open flower measures 20 mm. long, average diameter 3 mm. The peduncle is green, pubescent, measures 20 mm. in length, and bears two small caducous bracts at right angles to antero-posterior axis. (See pl. VI., fig. 5.)

Calyx brown, covered with dense layer of velvety hairs; segments 5, acute apex; when young, margin slightly recurved, but later very wide intersegmental grooves are formed. These pouches are at first nearly horizontal, but subsequently widen and become strongly reflexed, the apices of the segments remaining erect and in contact with corolla.

Corolla yellowish-white, pubescent, 15 mm. long, 12 mm. diameter; segments 5, obtuse or rounded apex, recurved in old flowers, 5 mm. long, 5 mm. wide at base.

Staminodes 5, epipetalous, alternate with corolla lobes and 2 mm. in length, occasionally smaller epipetalous alternating structures occur, probably rudimentary or abortive staminodes; *anthers* barren, yellowish-brown, bluntly apiculate; *filaments* white, short, glabrous.

Pistil green, pubescent, 6 mm. long, 5 mm. diameter; stigmas 5, green, short, undulating apices; ovary 10-celled.

Fruit large, 60–75 mm. long, 50 mm. diameter, sub-globose or ovate, slightly flattened at top, apple-green to black, glabrous or nearly so; fruiting calyx enlarged, flattened, woody, intersegmental groove large, margins strongly reflexed. (See pl. VI., fig. 8.)

Seeds 4–10 in each fruit, 30 mm. long, 15 mm. wide, 5 mm. thick, flattened and elliptical in shape; testa brown, shining, striated; endosperm copious, horny, equable. (See pl. VI., fig. 9.)

Seedlings epigeal, cotyledons detached early, epicotyledonary system enhanced in development and distinguishable in resting embryo (see pl. VI., fig. 6.); *cotyledons* white, when mature measure 25 mm. long, 12 mm. wide, oblong-ovate, blunt apex, squarish base, strong midrib; *hypocotyl* yellowish-green, rapidly turning black, glabrous or nearly so, 90–100 mm. long, diameter 3 mm.; *epicotyledonary* stem yellowish-red, 3 mm. long; *epicotyledonary* leaves, first two form an opposite pair at right angles to the plane of the defunct cotyledons, 60 mm. long, 30 mm. wide; *traces* 3 per cotyledon, median abortive, xylem not much split; epicotyledonary traces, one per leaf, probably continued into the root.

Timber.—The timber of this species—calamander—is considered to be one of the best for durability and ornamental purposes. It would be difficult to find a prettier variegated wood, though samples of D. Kurzii, received from the Conservator of Forests, Andaman Islands, come a good second for ornamental value. Hiern, mon. p. 162 (1873)

The timber is very scarce; the total amount exported from Ceylon during the last five years being 20 pieces only; these were sold in Colombo for Rs. 150. The specimens were in the form of planks, slabs, and small round pieces, the latter measuring 3 to 4 feet in length and 16 inches in circumference.

The heartwood, when present, is usually of a deep brown colour streaked with black. There is however, considerable uncertainty as to the presence and abundance of coloured

heartwood, and many very old trees have been felled which possessed only dirty white or brownish timber, which was therefore as useless as that obtained from D. Moonii. (See pl. V., fig. 17.)

The relative value of samples of calamander is determined by the quantities of coloured material filling the cells; it is not due to a particular type of histological differentiation. The black portions of calamander are not more durable than the heartwood of D. Melanoxylon or D. Ebenum; the deep brown portions are considerably less so. The value of calamander over other Diospyros woods is due to the particular abundance and more general distribution of the colouring materials characterizing the species.

The percentage of fibres varies from 80–86 per cent.; additional strands of parenchymatous tissue occur in the xylem (*cf.* D. Gardneri).

The rings of growth are inconspicuous.

The timber of D. oocarpa and D. affinis sometimes approximates to calamander in point of distribution of coloured substances in the central timber. In these two species, however, there is always a large proportion of useless sapwood.

Uses.—In addition to the timber being used whenever procurable, the ripe gummy fruits are eaten by the natives.

Distribution endemic, rare, this species being found only in the moist low-country up to 2,000 ft. The scarcity of this tree is not alone due to the value put upon its timber, but (*a*) to a curious mode of development, resulting in the death of many of the germinated seeds, (*b*) to the very slow rate of growth in the seedling and later stages; two-year-old saplings measure only 600 mm. (less than 2 feet) in height, and trees over 60 years old have a circumference of 472 mm. (19 inches) only, (*c*) to the diœcious flower system and the long interval between flowering periods.

There are a good number of trees on Hinidumkanda, and also in the Sinha Raja forest; Potapitiya, Kukulu korale;

Kuruwiti korale ; Ratnapura, Dotalankanda, Pasdun korale; Yagiralla, near Udugama ; Nahitimukalana, Atakalan korale; Pennelmukalana, Madampe district.

The trees grow well on rocky, porous, damp slopes, rich in silica and iron ; they vary from 0·6 to 2·4 metres (2–8 feet) in circumference, and 12 to 24 metres (40–80 feet) in height.

The largest specimen I have seen measured twelve metres (40 feet) before the first branch, total height 27·4 metres (90 feet), and breast height circumference of 2·4 metres (8 feet); this was a male tree, Yagiralla forest, 900 feet above sea level.

12. **Diospyros sylvatica,** *Roxb.* Cor. Pl., p. 37, t. 47 (1795)

Sudu-kadumberiya, S ; Karuppu Thoveria, T.

Alph. D.C. Prodr. VIII., p. 231. (1844). Thw. Enum. 178. C.P. 2,729, Fl.B. Ind. III,. 559 Bedd., Ic. Pl. Ind., Part VII., p. 25, t. 121 (1871). Hiern, Mon. Eben. 161.

A very large tree, attaining a circumference of 4 metres ($13\frac{1}{2}$ feet) and height of 61 metres (200 feet), evergreen, diœcious and polygamous ; trunk erect, buttressed at base, bark of twig shows coarse reticulation, bark of trunk blackish-gray, thick. *Leaves* alternate, 70-130 mm. long, 20-60 mm. wide, oval, acuminate apex, narrowed or rounded at base, glabrous or nearly so ; young leaves thin, old leaves coriaceous, deep green above, paler beneath ; venation reticulate, meshes wide, pellucid, midrib and veins depressed on upper side ; *petiole* flattened, feebly puberulous, 5–12 mm. long.

Polygamous trees.—These are very similar to D. Gardneri and D. Ebenum.

The seeds and seedlings from polygamous trees possess the same characters, anatomically and developmentally, as those obtained from pure female trees. All the flowers on these trees possess fertile stamens and a rudimentary or fertile pistil, those with fertile pistils being usually accompanied with larger accessory whorls. The absence of flowers with fertile pistils during the first few weeks of flowering has been noticed, and it seems quite probable that the production

of unisexual and hermaphrodite flowers may be effected during different periods. There is also a tendency for the hermaphrodite and unisexual flowers to occcur in separate clusters, though the mixed condition in the same inflorescence has been noticed (see pl. XI., fig. 4-6). The flowers are strongly aromatic, and Mr. Willis informs me that they are visited by many bees at Peradeniya.

Male inflorescence arises on lower part of young shoots in axil of caducous bract or foliage leaf ; when the latter the clusters are more crowded and abundant. The bud is enclosed in a sheathing bract; two small bracteoles appear on the primary peduncle at right angles to the antero-posterior axis, and in the axil of each a flower appears. Each lateral flower becomes the median flower of another cyme, and this is repeated until we have a crowded dichasial cymose inflorescence of 7, 15, or more flowers on a peduncle only 7–10 mm. in length. The first pair of lateral flowers have pedicels over 2 mm. in length, but the subsequent flowers are subsessile along their respective axes; bract subtending inflorescence green, hairy, caducous, 6–10 mm. long; the bracteoles are much smaller, green, hairy, caducous; flowers in April, fruits September-February. The inflorescence attains a length of 20 mm. and is similar to the male of D. Ebenum and D. Toposia. (See pl. XI., fig. 1–2.)

The *flowers* are small, white, fragrant and openly bell-shaped.

Calyx green, total height 3 mm.; segments 3-4, pubescent or ciliate, rounded apex, accrescent, 1 mm. long.

Corolla white, urceolate or campanulate, total height 8 mm., diameter at top 8 mm.; segments 3–4, rotate, glabrous, rounded apex, 3 mm. long.

Stamens irregular, 13–22, epipetalous, single or united in 2's or 3's forming usually about 8–10 groups; when in pairs the shorter anther is innermost (*cf.* D. Gardneri); *anthers* yellow, introrse, shortly apiculate, dehiscing laterally from apex; *filaments* white, united or separate, glabrous except near base of anther.

Pistil absent or rudimentary, flat disc, 2 mm. diameter, undulating, exhibits locular structure.

Female flowers solitary, or as a cyme of 3 flowers on peduncle of varying length; pedicels of each flower short, bracteate. (See pl. XI., fig. 8).

Calyx green, 12 mm. diameter; segments 3–4–5, rounded apex, 8 mm. long.

Corolla yellowish-white, 11 mm. long; segments 4. rounded apex, 3 mm. long.

Staminodes 4, epipetalous, alternating with corolla segments, glabrous, white.

Pistil 3 mm. long, 2 mm. diameter; stigmas 3, deep green, glabrous; ovary 6-celled, broad base, tapering apex, green. glabrous.

Fruit globose, smooth, dark gray, 12–20 mm. high, 10–15 mm. diameter; fruiting calyx enlarged, flat or accrescent, thin and not woody, 15–20 mm. diameter.

Seeds 2–4–6 per fruit, 14 mm. long, 10 mm. wide, 6 mm. thick; ovate or globose in shape; testa brown, streaked; endosperm abundant, strongly ruminate and very rich in tannin; embryo white and small, 6 mm. long. (See pl. XI., fig. 7).

Seedlings epigeal, cotyledons persistent. The whole or greater part of the endosperm is absorbed before the testa splits; *epicotyledonary* system does not appear until several weeks, and in one case five months after cotyledons mature.

Cotyledons cordate, rounded base, tapering obtuse apex, glabrous, 25 mm. long; *hypocotyl* red, glabrous, thin, 80 mm. long; *epicotyledonary* stem very short and developed at a late stage; *epicotyledonary* leaves—first leaf appears about 1 mm. above cotyledonary node, second about 2 mm. above first; alternate, deep green, tapering strongly towards base, rounded apex, venation feebly pellucid, 20 mm. long, 11 mm. maximum width; *traces* two per cotyledon, xylem splits forming 8–15 groups; one trace per epicotyledonary leaf, not prolonged into root. Below the collet most seedlings show a

crude octarch exarch cylinder with protoxylem groups joined by strongly lignified perimedullary zone. (See pl. XVII., fig. 5, 6).

Timber when freshly felled is yellow or white with a variable but usually small quantity of black heartwood; inferior but often used for fancy work and buildings. The yellow colour (*cf.* D. Gardneri) is due to the preserving, in very small quantities, of brown or yellow contents in the parenchymatous and tracheal elements. The medullary ray cells of the sapwood possess contents some of which show signs of disintegration and acquire a distinct colour in passing to the heartwood. The number of parenchymatous cells with such contents increases considerably from without inwards and in addition many of the vessels become partially filled with gum-resin of a yellow colour. (See pl. II., fig. 7). The differentiation of the elements is fairly regular; the percentage number of fibres is rather high. This species is only rarely felled for its timber. The rings of growth are visible to the naked eye; sometimes they have a radial diameter of 1 mm. but occur at very irregular distances from one another.

Uses.—The timber though inferior in quality is sometimes used in fancy work. The fruits when ripe are a trifle fleshy; they are occasionally eaten.

Distribution rather rare and limited to the wet zone up to 4,000 feet; Hantana, Gangaruwa, Watagoda, Ekneligoda, Ambalawa, Sinha Raja forest.

Also in S. India.

13. **Diospyros Melanoxylon** *Roxb.* Cor. p. 36, t. 46 (1795). Kadumberiya, S.

Alph. D. C. Prodr. VIII., p. 224 n. 7 (1884). Fl. B. Ind. III., 564.

Roxb. Cor. Pl. t. 46. Hiern, Mon. Eben. 159.

A medium-sized or large tree, evergreen, diœcious (polygamous?); bark deeply fissured in alternate grey and black layers, fissures running vertically for a great distance; 100

mm. long, 20 mm. wide ; the bark is 10 mm. in thickness on branches 40 mm. diameter ; young twigs green, pubescent, become glabrous, white and shiny.

Leaves very variable in position and size ; usually opposite, sometimes sub-opposite or alternate, often crowded at end of twig, 40–140 mm. long, 15–70 mm. wide, (on suckers the leaves are often 240 mm. long and 100 mm. wide), oblong-oval, rounded or obtuse apex, tapering base, pubescent when young, glabrous and shiny when old, under-surfaces duller green than upper ; venation reticulate, meshes wide, pellucid ; lateral veins not very conspicuous above, prominent below ; *petiole* green, glabrous or hairy, flat above, 4 mm. diameter, 15 mm. long.

Male inflorescence usually consists of a dichasial cyme, 3–7–flowered, similar to that described for D. sylvatica, D. Toposia, &c., and occurs in lower part of young shoot in axil of leaf or caducous bract ; sometimes the lateral flowers do not arise in opposite pairs but at different levels suggesting a racemose type. (See pl. VIII., fig. 8).

When the inflorescence is represented by a central flower only, the bracteoles are nevertheless present ; the flowers which should occur in the axil of bracteoles in the plane of the antero-posterior axis are commonly absent.

The main peduncle is pubescent, 3–11 mm. long, 2 mm. diameter ; pedicels of first pair of lateral flowers longer than those of second pair and measure 15 mm. in length and 2 mm. in diameter ; bracts and bracteoles long, pubescent, size gradually decreasing from bract to youngest bracteole.

Male flowers in bud are green, pubescent, 5 mm. long, 3 mm. diameter ; open flower 13 mm. long ; there is much variation in the number and orientation of the members of accessory whorls and stamens.

Calyx yellowish-green, pubescent, campanulate, 5–8 mm. long, 5 mm. diameter, occasionally very small ; segments 3–6 and accrescent, apex acute, 1·5–3 mm. in length.

Corolla yellowish-white, narrow-throated, outside covered with silky hairs, 12 mm. long, 3 mm. diameter : segments

4–6, usually 5. rotate, rounded or acuminate apex, 2 mm. long, 2 mm. wide.

Stamens indefinite, 8–10–16–20, never epipetalous but terminate central disc, arranged singly or in equal or unequal groups of 2 or 3 ; in one case 15, arranged (*a*) outer whorl of 8, four in two connate adjacent pairs, and four successive separate stamens; (*b*) inner whorl of 7, two of which were connate (*cf.* D. pruriens) ; in another case 13, ten in 5 pairs with anthers of inner stamens shorter than outer, two as a pair with anthers of equal length, and one separate stamen with long anther and filament ; *anthers* yellow, glabrous, slightly apiculate, 1·8–3 mm. long, opening by longitudinal slits ; *filaments* white, glabrous, 1·5–2·5 mm. in length.

Pistil absent or represented by bunch of hairs or apiculate rudiment 2 mm. long.

In one or two cases I suspected polygamy, but was not able to prove the undoubted occurrence of this condition.

Female flowers solitary in axil of foliage leaf, large ; in bud measure 5 mm. in length and 6 mm. in diameter ; accessory whorls very unequal ; peduncle short and stout, covered with light brown hairs, 1·5 mm. long, 3 mm. diameter ; two small hairy bracteoles on peduncle forming an opposite pair at right angles to antero-posterior axis (*cf.* D. affinis and D. Ebenum) 2mm. long, broad base, acute apex ; occasionally a third bracteole occurs placed between flower and axis. (See pl. VIII., fig. 6).

Calyx green to brown, deeply lobed, pubescent, forming rather shallow cup ; segments 4–7, usually 6, accrescent, tapering apex, broad base, margins undulate, 7 mm. long, 5 mm. wide, become more nearly horizontal after fertilization.

Corolla yellow, wide-throated, white base, both surfaces covered with silky hairs, 9 mm. long, 5 mm. diameter ; segments 5, tapering apex, 3 mm. long, 2·5 mm. wide.

Staminodes indefinite 8–10–12, rarely epipetalous, when 12 in number they are opposite and alternate to calyx segments; *anthers* reddish-brown, barren, apiculate, glabrous, 1·5 mm. long; *filaments* yellowish-white, glabrous, 2·5 mm. long.

Pistil green, globose, densely pubescent; stigmas 4, green, hairy, and fleshy; ovary globose, 7 mm. long, 4 mm. diameter; 4–6-celled, but orientation of loculi very irregular; ovules usually disposed at right angles to the plane of antero-posterior axis and this apparently in consequence of pressure.

Fruit solitary, green, globose-apiculate with few persistent hairs, 40 mm. high, 30 mm. diameter, 2–4-celled; fruiting calyx slightly enlarged, 25 mm. diameter, pubescent, reflexed and undulated margin, small intersegmental groove; acute apex of segment remains in contact with carpellary wall. (See pl. VIII., fig. 7).

Seeds 1–4 per fruit, oval-wedge shape, 21 mm. long, 10 mm. wide, 8 mm. thick; testa reddish-brown; endosperm copious, horny, ruminate; embryo white, 15 mm. long.

Seedlings.—None of the seeds germinated, but from a study of the embryo the following points were made out:—Traces three per cotyledon, epicotyledonary traces prominent and distinguishable in the resting embryo. The seedlings are very probably of the ordinary epigeal type with cotyledons which become detached at an early stage.

Timber.—This species is one of the main sources of Indian ebony, possessing very durable black or streaked heartwood. It is spoken of as Coromandel wood by Dr. Watt (Econ. Prod.) and it is difficult to understand why Trimen (Fl. Ceyl., p. 99) refers to it as inferior to that of D. Ebenum. The majority of the trees still in Ceylon are certainly small and cannot yield much good heartwood. In one large tree trunk 320 mm. diameter the black heartwood measured 120 mm. in diameter; in another stem 270 mm. diameter, the heartwood measured 110 mm. diameter—a proportion which compares favourably with D. Ebenum. (See pl. I., fig. 5).

The contents of the parenchymatous and tracheal elements are, as one might expect, always conspicuous. In the red sapwood the coloured contents are almost limited to the medullary ray cells, but in the black heartwood every element is filled with reddish-brown materials. A discolouration also appears in the walls.

The differentiation of the elements is comparatively regular. The percentage number of fibres is approximately 81, and the maximum variation is presented in the cells of the wood parenchyma. Insignificant rings of growth can be distinguished, sometimes continuous throughout the section, at other times on one side only. I believe that if old trees of this species were only more abundant we should have a valuable source of ebony, quite equal to D. Ebenum from an economic point of view. Its limited distribution in Ceylon is not due to non-production of fruit.

Distribution.—This species is very rare in Ceylon. It was first found between Bibile and Ekiriankumbura, Uva, in 1888. It was unknown to Thwaites and according to Trimen (Fl. Ceyl. p. 99) there were no known specimens from the Island except from the above locality. The flowers were first obtained in Ceylon, in May, 1901.

It occurs on the patana and coarse forests to the south-west of Bibile in the localities Elukkapudena, Antibuwana, and Diggalrana. At the first-mentioned place at an elevation of 700–900 feet, the tree is found on patana ground, and there rarely exceeds a total height of 9·1 metres (30 feet) and breast height circumference of 305 mm. (1 foot), though the trees are probably very old. At the latter places, the tree reaches a height of 18·3 metres (60 feet) and circumference of 1–1·67 metres (3½ feet—5½ feet).

Other trees also occur along the Bibile-Bintenna road, near Bibile, at the base of a small hill.

Uses.—The Sinhalese call the tree Kadumberiya in this district. They collect the unripe fruits and after steeping them in water for two to three days, pronounce them fit to eat. Ripe fruits are abundant from May to July.

This species is abundant in Peninsular India.

14. **Diospyros hirsuta,** Linn. fil. Suppl., p. 440 (1781).

Thw. Enum. Ceyl. Pl., p. 181. n. 15 (1860). Alph. DC. Prodr. VIII., p. 223, n. 5 (1844). Bedd. Icon. Pl. Ind. Or. 1871. Hiern, Mon. Eben. 163. C. P. 382. Fl. B. Ind. III., 565. Hiern, p. 163–164, includes D. Moonii, Thw. and D. Thwaitesii Bedd., as varieties of D. hirsuta, L., but for reasons given this grouping cannot be maintained.

A small or moderate-sized tree, evergreen, diœcious, monœcious, and polygamous ; bark black with narrow irregular grooves and ridges ; branches pubescent when young, often groups of stiff brown hairs occurring in local areas on young twigs (*cf.* D. Thwaitesii).

Leaves alternate, 90-200 mm. long, 30-60 mm. wide, ovate-lanceolate, tapering apex, obtuse or acute, tapering base ; young leaves densely pubescent, hairs persisting on under-surface, lateral veins and midrib ; sub-coriaceous, pale green below, venation reticulate ; *petiole* 8-11 mm. long.

Flowers March–October ; ripe fruits March–August.

The polygamous condition is very frequent as a result of the fertility of the pistil in male flowers ; the hermaphrodite flowers occur in any cluster, and consequent on the ripening of the fruit the unisexual flowers become detached leaving only one or two fruiting specimens out of a many-flowered cluster. A single twig or herbarium specimen may therefore appear to be female only.

The monœcious condition has been observed by Thwaites. I have confirmed this in material obtained from Potgulkanda near Ratnapura. The same inflorescence possesses male and female flowers, the former with rudimentary pistil and the latter with barren staminodes. (See. pl. XV., fig. 9).

The male inflorescence consists of dense axillary cymes, sometimes short, at other times drawn out to a length of 20 mm. All the flowers are sessile or subsessile, but an opposite pair of small pubescent bracteoles occurs at the base of each flower suggesting a suppressed dichasial cyme.

Calyx green, pubescent, irregularly lobed ; segments 4–5, accrescent, acute apex, 36 mm. long.

Corolla yellow, with narrow throat, diameter of mature flower 5 mm. ; segments 4–5, overlapping in bud with exposed half externally pubescent, become horizontal when flower mature, acute apex.

Stamens 5, epipetalous, alternate with corolla segments ; *anthers* brown, glabrous, apiculate, 2·5 mm. long ; *filaments* white, short ; pollen yellow, smooth, circular.

Pistil central rudimentary.

Female inflorescence consists of a sessile cluster of flowers in the axil of a leaf, fewer than male, never solitary except by falling away of young flowers ; bracteoles as in male.

Calyx, larger than in male ; segments 4–5, covered with long brown unicellular hairs, 10 mm. long, accrescent in bud with feeble intersegmental pouch.

Corolla yellow, thick ; segments 5, acute apex.

Staminodes 5, epipetalous, alternate with corolla segments ; *anthers* brown, barren, apiculate, glabrous, 2 mm. long ; *filaments* white, glabrous, 0·3 mm. long.

Pistil brown, thickly coated with unicellular hairs which persist in ripe fruit (*cf.* D. Moonii, D. Thwaitesii) ; stigmas 1, sessile ; ovary globose-apiculate, 8–celled (*cf.* D. Thwaitesii).

Fruit broadly globose-ovoid, apiculate, 30 mm. high, 70 mm. in circumference, hairs detached only with difficulty ; fruiting calyx persistent, enlarged, flattened, thick, margins much reflexed and undulated, segments 15 mm. long.

Seeds 1–8, usually 6 per fruit, elliptical-wedge-shaped with beaked micropyle, 20 mm. long, 10 mm. wide, 9 mm. thick ; testa brownish-black, prominently striated transversely ; endosperm copious, horny, ruminate ; embryo white, 10–14 mm. long. (See. pl. XV., fig. 11–12).

Seedlings epigeal, cotyledons detached early, epicotyledonary system enhanced developmentally and can be seen by the naked eye in the seed ; *cotyledons* white, long and narrow, measuring when mature 18 mm. in length and 6 mm.

in width; *hypocotyl* white, stout, glabrous, 60–65 mm. long; *epicotyledonary* stem yellowish-green, pubescent, 3 mm. long; epicotyledonary leaves form an opposite pair and prior to the dropping of the cotyledons attain a length of 15 mm. though within the confines of the seed; hairy on under-surface, particularly midrib and margin; *traces* three per cotyledon, median abortive, laterals splitting considerably; epicotyledonary one per leaf prolonged into root.

The timber possesses no black heartwood, and when freshly cut is dirty white in colour turning reddish on exposure; the colour is due to coloured contents mainly in the wood parenchyma and medullary ray cells; a change in colour of the walls occurs. (See pl. I., fig. 3.)

The percentage number of fibres varies from 74–83 per cent. and that of the tracheal elements from 0·3 to 1·3 per cent.

The rings of growth are inconspicuous.

In the Peak Wilderness I came across a variety of this species characterized by a flattened circular fruit and stout persistent style. It was abundant along the banks of streams and in damp forests near Eratna, Madola, and Kadawatta.

Distribution.—endemic and limited to our wet zone up to 1,500 feet, rather rare but often abundant along the banks of streams and in rocky damp forests.

Katugasella, Potgulkanda, Kukule korale, Galle, Ratnapura, Nawadun korale, Eratna, Kadawatta, Madola.

15 **Diospyros insignis,** Thw. Enum. Ceyl. Pl., p. 180., n. 10 (1860).

Gona Poruwa-mara, Wal-mediriya, S.

Thw. Enum. 180. Hiern, Mon. Eben. 157. C. P. 2,730 (3,477).

Fl. B. Ind. III., 564. Bedd. Ic. Fl. Ind. Or. t. 130 (1871).

A moderate-sized tree, rarely exceeding 200 mm. diameter, with a straight stem unbranched until near the top, evergreen, diœcious and polygamous (monœcious ?); bark white or grey, characterized by long shallow irregular

cracks about 10 mm. apart, running vertically through a distance of 100–200 mm.; peels off in large thin flakes exposing brown surface ; young twigs thick, green and pubescent; the habit and bark characters are very pronounced.

Leaves alternate or sub-opposite, 140–240 mm. long, 40–120 mm. wide, ovate-lanceolate or oblong, acute apex rounded or narrowed at base, glabrous, toughly membrane ous, pale green beneath ; venation conspicuous, midrib and lateral veins project on lower surface, lateral veins connected by parallel transverse veinlets; *petiole* green, cylindrical, glabrous, 15 mm. long, 2·5 mm. diameter.

The polygamous state is very common ; the same stages as determined in D. sylvatica, D. Gardneri, and D. affinis have been observed for this species. The hermaphrodite and male flowers occur on the same tree, showing all stages between a central apiculate disc and a pistil with an 8-celled ovary; the hermaphrodite flowers may occur in the same cluster as the male, or in separate clusters, the occurrence being very erratic. (See pl. XIV., fig. 2).

Male inflorescence consists of an axillary subsessile cluster, 3–10 flowers similar to those described for D. hirsuta; flowers in March on stems 60 mm. diameter. (See pl. XIV., fig. 1).

Calyx green, 4 mm. long ; segments 4, short, accrescent, ovate, acute apex, nearly glabrous.

Corolla yellowish-white, shortly tubular, 10 mm. long, narrow-throated when mature : segments 4, rotate, short, pale and hairy outside.

Stamens 14–16–20, epipetalous at base of corolla, single or paired, inner shorter than outer, average length 5 mm., very unequal; *anthers* brown, apiculate, longer than filaments, length 3·5 (outer), 2 mm. (inner); *filaments* white, glabrous or pubescent, length 3 mm. (outer), 0·5 mm. (inner).

Pistil apiculate central disc, pubescent, 5 mm. high ; crude locular structure seen in transverse section.

The female flowers have not been previously described.

Female inflorescence consists of solitary or sessile axillary clusters of 1–6 flowers. (See pl. XIV., fig. 3).

Calyx green, pubescent; segments 4, 5 mm. long, accrescent in flower with feebly recurved margin and small intersegmental pouch.

Corolla yellowish-white, tubular, 10 mm. long, throat narrow; segments 4, outside covered with silky hairs, tend to become recurved in mature flower.

Staminodes 4–5, epipetalous; *anthers* barren, apiculate; *filaments* white, glabrous or nearly so.

Pistil green, feebly pubescent; stigmas 4, green, ovary 8-celled; after fertilization becomes enveloped in rapidly growing calyx and only stigma can be seen for some time.

Fruit green, glabrous except near apex, subglobose with cruciform depressed apex, with calyx like an acorn in appearance, 40 mm. high, 75 mm. circumference; fruiting calyx considerably enlarged, segments woody, 20 mm. long, with apices strongly pointed and projecting outwards and downwards, margin recurved and coated with long velvety hairs; in mature fruit the calyx is strongly tetrahedral in outline, and the basal part forms a cup over 20 mm. deep in which fruit rests (*cf.* D. Ebenum). (See pl. XIV., fig. 4).

Seeds 4–7–8 per fruit, oval-wedge shape; 28 mm. long, 11 mm. wide, 7 mm. thick; testa smooth, deep brown, transverse striæ not prominent; endosperm copious, horny, ruminate.

I have often suspected the monœcious condition in this species, but the occurrence of pure male and female flowers on the same tree has yet to be definitely proved. On some male trees I have found young flowers possessing a fertile pistil and a staminal whorl of five members, but whether these anthers were barren in consequence of being young or otherwise I could not satisfy myself.

There appears to be a variety of this species in the Ratnapura District, characterized by smaller leaves and fruits, darker bark, and less feebly cornered fruiting calyx.

Seedlings epigeal, cotyledons detached early, epicotyledonary system slightly enhanced developmentally. *Cotyledons* white, 10–13 mm. long, 4–6 mm. wide; *hypocotyl* white, glabrous, very short type similar to D. oocarpa and suggestive of hypogeal tendency; seeds are never raised above the ground and the hypocotyl is never strongly arched; 15–20 mm. long. Epicotyledonary system is long and narrow and easily frees itself from the confines of the decaying cotyledons and endosperm, and at the time of detachment of cotyledons measures 10 mm. in length and 1–5 mm. diameter.

The *epicotyledonary* stem when 65 mm. long bears 3–5 small leaves about 1 mm. in length and disposed at irregular distances; at the apex there are two larger leaves, opposite, but at different levels; these are glabrous, thin, bullate, and measure 50 mm. in length.

Traces 3 per cotyledon, xylem splits at different levels of hypocotyl and primary root. One trace per epicotyledonary leaf, but on account of splitting of cotyledonary xylem difficult to follow.

Timber.—Trimen (p. 100) describes the heartwood as being small and black with pale streaks, and states that it is one of those called "kalumediriya"—the Sinhalese name for calamander. At Ratnapura I found this belief still strong and it was only after much persuasion that trees on private grounds were felled for my inspection. Every specimen which I have seen is white when freshly cut, turning a dirty colour on exposure. Only on one occasion was the black heartwood present and this was very small and rotten. (See pl. III., fig. 3).

The gum-resin is present in very small quantities; the soft parenchymatous tissues are very abundant, and the timber must therefore be regarded as of an inferior quality. The tree provides excellent straight posts and is therefore frequently felled. The rings of growth are very inconspicuous, sometimes they occur as broad dark bands alternating with narrower and lighter zones. These are sometimes so closely

arranged that a radius of 10 mm. may contain 12 rings, whereas in some specimens very large areas may be free from any such differentiations. Perhaps such rings of growth are the expression of special periods of activity, independent of seasonal forces ?

Distribution.—This species is common in the moist low-country up to 2,500 feet; Kandy, Polgahawela, Ambagamuwa, Avisawella, Kuruwiti korale, Hewesse, Kalutara, Kottawa, Potgulkanda, Katugasella, Udugama, Yagarilla, Penjaval, Hinidun, Eratna, Kadawatta, Ambalawa, Pindeniya, Pitigalla.

Also in Anamalai Hills, South India.

16. **Diospyros oppositifolia,** Thw. Enum. Ceyl. Pl., p. 181., n. 11 (1860).

Kalumediriya, Kadumberiya, S.

Thw. Enum. 181. Hiern, Mon. Eben. 157. C. P. 3,011.

Fl. B. Ind. III., 565. Bedd. Ic. F. Ind. Or., t. 131.

A moderate-sized or large tree, evergreen, monœcious only ; trunk erect, not buttressed, bark black, never deeply grooved but fissures somewhat similar to D. insignis. *Leaves* opposite or sub-opposite, 50–130 mm. long, 35-75 mm. wide, oval, shortly acuminate or obtuse apex, rounded at base, pubescent when young, glabrous when old, coriaceous ; venation reticulate, pellucid, lateral veins and parallel transverse connecting veins conspicuous when fresh ; *petiole* dark, glabrous, 2-5 mm. long ; phyllotaxy, texture and form somewhat similar to D. Melanoxylon.

The male and female flowers are always found together on the same tree. Usually a solitary female flower terminates the young shoot, and in the axils of the lower leaves clusters of male flowers arise. In one specimen male and female flowers were in separate but opposite clusters of 9 and 2 flowers respectively on a young twig ; in another case there were two residual flowers of a cluster, one of which was a true male, the other showing a ripening pistil ; in other cases the female flowers may occur solitary in the axil of the

lower leaves. There was very little evidence of a constant or annual floral periodicity in the trees examined. It is interesting to note that though this endemic species is monœcious, only the male flowers have been previously described. The sex, female flowers, and fruits are here described from material I obtained in the forest in 1901.

Male inflorescence consists of a sessile or subsessile cluster of 1–9 flowers in the axil of leaves or on old twigs. The male flowers never terminate a young shoot and usually occupy the part below the female flower or flowers; they are rarely mixed with female flowers in the same cluster. Each flower is subtended by a small caducous green bracteole. The flowers are yellow, fragrant when fresh and measure 10 mm. when unopened. (See pl. VI., figs. 3, 4).

Calyx brown or green, diameter 16 mm.; segments 4, acuminate apex, sub-glabrous, 4 mm. long.

Corolla yellow, tubular, swollen at base, when open measures 15 mm. long; segments 4, rotate, with tapering acute apex, half of outer surface covered with brown hairs, 5 mm. long, 2·5 mm. wide at base.

Stamens 8 (4+4), epipetalous, usually in pairs but filaments not united, inner shorter than outer; pairs usually alternate with corolla segments, though liable to variation; *anthers* yellow, apiculate, glabrous apex, hairy at back, 2·5 mm. long; *filaments* white, covered with long unicellular hairs, 1 mm. long, sometimes absent or very short for inner stamen.

Pistil absent or as a central pubescent apiculate structure.

The female flowers and fruits have not been previously described. Flowers usually solitary terminating young shoot, subsessile or on peduncle measuring 8–15 mm. long, 2 mm. diameter; peduncle greenish, finely pubescent, and may or may not bear bracteoles; yellow, fragrant. (See pl. VI., fig. 1).

Calyx green, outside finely pubescent, 9 mm. total length, diameter 4 mm.; segments 4, rarely 3, deeply cut, tapering acute apex, thick, 6 mm. long.

Corolla yellow, outside covered with short white hairs, 16 mm. long when unopened, diameter of open flower at top 20 mm.; segments 4, rarely 3, rotate, tapering acute apex, 10 mm. long.

Staminodes 4, epipetalous, alternate with corolla segments; in one case there were eight separate staminodes each typical in form and having barren anthers; *anthers* barren, brown, tapering apex but not apiculate, 2 mm. long; *filaments* white, glabrous, 1·5 mm. long.

Pistil with 4 stigmas, yellowish-watery appearance, thin and undulating; style stout, 4 mm. long, 1·5 mm. diameter; ovary small, greenish, nearly glabrous, 8-celled, the loculi of adjacent pairs becoming grouped opposite the middle of calyx segments.

Fruit solitary, terminates young shoot, ovoid-attenuate, 30 mm. long, 12 mm. diameter, green, glabrous. Some fruits have a broad base and taper quickly towards apex; others are narrow at base and strongly attenuate at apex; fruiting calyx woody, enlarged, forming deep cup for fruit, total length 18 mm., cup 18 mm. diameter. (See pl. VI., fig. 2)..

Seeds 2-5 per fruit, wedge-shaped having convex surface in contact with carpellary wall, tapering strongly towards both ends; 28 mm. long, 10 mm. wide; testa brown, smooth; endosperm copious, horny, equable.

Embryo white.

Timber.—Regarding the wood from this species, Trimen states (Vol. III., p. 101) that according to Thwaites the timber resembles true calamander, but that the tree requires more careful examination and is almost unknown. The Sinhalese name is the same as that applied to calamander. My experience does not confirm this. The timber when freshly felled is white or dirty white in colour, with a hollow decayed centre. Young trees 75 mm. (3 inches) diameter are invariably hollow in the centre, and large trees measuring 480 mm. diameter possess only a narrow peripheral band of dirty white living wood, the central and median portions

being quite rotten. On exposure the timber changes to a darker colour with irregular streaks of black, often giving a pattern to the transverse section similar to what has been noted in D. ovalifolia. (See pl. II., 8).

The discolouration is often due to a change in the colour of the cell walls only. The relative scarcity of gum-resin and the abundance of parenchymatous cells, particularly of the medullary ray, necessarily make the timber very inferior in quality.

The rings of growth are inconspicuous.

Distribution.—This is our rarest species of Diospyros and up to the present has only been found on the upper part of the Haycock mountain, or Hinidumkanda, between 1,500-2,000 feet. The climate there prevailing is unique, the upper part being, more often than not, capped with mist, and arborescent vegetation is of a stunted xerophytic type. There are not more than 40 or 50 trees of this species and these occur mixed with trees of calamander. The character of the erect trunk with its black bark is very similar to that of calamander trees, and the fact of their being so freely mixed with trees of calamander is probably the source of the error regarding the value of the timber. This species should grow well on the steep rocky hill sides in the Peak Wilderness, where the rainfall is high.

17. **Diospyros Thwaitesii,** Bedd. Ic. Pl., Ind. Or. 27 (1874).

Kadumberiya, S.

Hiern, Mon. Eben. 164. C. P. 3394. Fl. B. Ind. III., 566. Bedd. Ic. Pl. Ind. Or. t. 135

A small or medium-sized tree, 300-1,500 mm. in circumference, and attaining a height of 18 metres (60 feet), evergreen, diœcious, monœcious, and polygamous; bark black, slightly rougher than D. hirsuta, with longitudinal fissures 2 mm. deep and 4 mm. wide; bark 3 mm. thick in tree 110 mm. diameter, young twigs covered with brown hairs becoming green and glabrous. *Leaves* alternate, 80-120 mm. long, 20-40 mm. wide, ovate-lanceolate, tapering towards apex:

apex acute or obtuse, tapering base, pubescent on both surfaces when young, especially midrib, glabrous and shining when old, thin, venation reticulate, meshes wide, midrib prominent beneath, lateral veins inconspicuous; petiole green, finely pubescent, slightly grooved above, 8 mm. long, 2 mm. diameter. Flowers in March to June; fruits March-October.

The monœcious condition was seen at Palaketi, near Udugama. The male clusters and female flowers occur irregularly on the same or different twigs. I fully satisfied myself that the 5 staminodes in the fruiting flowers were barren, this being the species in which the monœcious condition was first noticed. The polygamous condition established by the occurrence of male and hermaphrodite flowers on the same tree is very frequent. Pure male and female trees occur in the same district, and it occurred to me that perhaps the trees now bearing unisexual flowers may at another time of the year produce hermaphrodite flowers. The sex appears to be very unstable. (See pl. XVI., fig. 3–4).

At Palaketi there is a variety of this species characterized by broader and coriaceous leaves, in which the lateral veins and midrib are conspicuous on the upper surface, and measure 40–120 mm. long and 30–50 mm. broad.

The male inflorescence consists of a sessile axillary cluster of 4–15 flowers; each flower is subtended by a small bracteole, 2 mm. long, acuminate apex, green and glabrous above, covered with red hairs below. (See pl. XVI., fig. 1).

Calyx green, hairy, 3 mm. diameter, 4 mm. long in open flower; segments 5, accrescent, with tapering apex, not undulate in flower.

Corolla yellowish-white, 8 mm. long, 8 mm. diameter of open flower at top, throat widely open and covered above and below with silky hairs; segments 5, rotate, tapering apex, broad base, half of flower surfaces covered with brown hairs.

Stamens variable but usually 5 epipetalous pairs alternating with corolla segments, attached by separate or united

filaments ; in other cases 10–18 arranged in pairs and singles without fixed orientation ; *anthers* unequal, reddish-brown, apiculate, apex well pointed with long unicellular hairs to disseminate the pollen, average length 3 mm. ; *filaments* yellowish-white, glabrous, 1·5 mm. long ; *pollen* yellow, even outline, circular, feebly granular contents.

Pistil rudimentary disc, apiculate, densely pubescent.

The female flowers occur solitary, or as a cyme in the axil of foliage leaves ; when solitary the flower is surrounded with an involucre of small bracteoles suggesting 3–7-flowered inflorescences ; bracteoles with hairy midrib, acute apex, 9 mm. long, 5 mm. wide. (See pl. XVI., fig. 2).

Calyx brown, pubescent, campanulate in flower measuring 10 mm. in depth ; segments 5, tapering apex, slightly reflexed margin, undulating intersegmental groove, pubescent.

Corolla yellowish-white, 10 mm. diameter, corolla throat wide ; segments 5, rotate, acute apex, half of under surface densely pubescent.

Staminodes 5, epipetalous, alternate with corolla segments, filaments attached near apex of throat ; *anthers* barren, brown, apiculate with silky brown attenuate hairs as in male ; *filaments* white, very short. *Pistil* with 2 stigmas, yellowish-white, style absent ; ovary globose-apiculate covered with dense coating of brown hairs, 4-celled, one ovule in each cell.

Fruit globose-apiculate covered with long brown hairs when young, but tending to become glabrous when old, 30 mm. long, 60 mm. circumference ; fruiting calyx not much enlarged. (See pl. XVI., fig. 5).

Seeds 2 per fruit, oval-elliptical in shape, with strongly beaked micropyle ; 18 mm. long, 10 mm. wide, 8 mm. thick ; testa brown, transversely striated ; endosperm abundant, ruminate. (See pl. XVI., fig. 6).

Seedlings epigeal ; *cotyledons* drop, but usually only after persisting as a white lamina, void of palisade tissue, for one or two days. During this time they never develop any chlorophyll though the enhanced epicotyledonary leaves

are of a deep green colour ; cotyledons white, 20 mm. long, 12 mm. wide ; *hypocotyl* white, thinner than D. Moonii, 85-90 mm. long; *epicotyledonary stem* pubescent, a trifle longer than D. Moonii, 6-10 mm. long ; epicotyledonary leaves form an opposite pair, cordate, tapering acute apex, midrib hairy beneath, 25 mm. long, 20 mm. broad. Three *traces* per cotyledon, xylem of median trace abortive and liable to be overlooked in sections not horizontal ; one trace per epicotyledonary leaf, continued into the root but in old seedlings absent from the apical part of the root.

Timber.—The sapwood when freshly cut presents a dirty appearance while the heartwood is light red. There is no real black heartwood, only small black traces here and there. The coloured materials in the various elements are small in quantity ; fibres are abundant and medullary rays poor, hence an even-grained timber results. Rings of growth sometimes conspicuous, the light narrow rings measuring 0·2–1·2 mm. radial diameter and being distanced 2–8 mm. radially from one another. (See pl. II., Fig. 9).

Distribution.—This species is found in the moist low-country forests, rather rarely; it grows well on moist, rocky, or sandy soils, and under close canopy usually measures 4·5–6 metres (15–20 feet) to first branch, and has a total height of 6–9 metres (20–30 feet), the average circumference being about 320 mm. The largest trees occur at Hiniduma at an elevation of 800 feet, measurements already quoted. Ratnapura, Hiniduma, Sinha Raja forest, Hewess, Palaketi.

18. **Diospyros Moonii,** Thw. Enum. Ceyl. Pl., p. 182., n. 16 (1860) Kadumberiya, Kaluwella, S.

Thw. Enum. 182, C. P. 2,833. Hiern, Mon. Eben. 164. Fl. B. Ind. III., 566. Bedd. Ic. Fl. Ind. Or. t. 138.

A moderate-sized tree, evergreen, diœcious ; small trees have a relatively smooth black stem, but larger specimens are deeply grooved and buttressed at the base ; average height from 7·6–10·6 metres mm. (25-30 feet), maximum 13·8 metres (45 feet), breast height circumference 760 mm. (2½ feet) ;

young branches black and smooth ; on old twigs the bark is rather scaly and pinkish-red turning to brown when freshly cut.

Leaves alternate, 190–350 mm. long, 70 mm. wide, ovate-lanceolate, short tapering acute apex, rounded base, pubescent when young, glabrous or nearly so when old, thick and leathery ; venation reticulate, meshes wide, not pellucid, lateral veins rather conspicuous below ; midrib prominent below, channelled above ; *petiole* green, cylindrical, 15 mm. long, 5 mm. diameter. Flowers October, ripe fruits March to October.

Male inflorescence consists of a sessile cluster of 1–8 flowers on old twigs ; bracteole subtending each flower green, pubescent, tapering acuminate apex, broad base early caducous 3 mm. long, 3 mm. wide at base. (See pl. XVI., fig. 7).

Calyx brown, hairy ; segments 5, 4 mm. long, acute apex. *Corolla* yellow and 5–lobed ; *stamens* five ; *pistil* rudimentary. Fresh specimens of open flowers not seen.

Female flowers solitary or as a sessile inflorescence ; a ring of 2–5 bracts at base of solitary flower, 8 mm. long, 4 mm. wide. (See pl. XIV., fig. 6).

Fresh material of young flowers not seen.

Calyx green, pubescent, cupuliform ; segments 5, bluntly apiculate, recurved margin, slight intersegmental groove.

Corolla yellowish-white and 5-lobed ; staminodes present.

Pistil globose, pubescent. *Fruit* solitary or in groups 2–4, sessile or subsessile, globose with depressed apex, 90–130 mm. circumference, 30–50 mm. long, green, slightly hairy, long hairs easily detached, 10–celled ; fruiting calyx persistent to fruit, enlarged, segments measuring 15 mm. in length, flattened, densely pubescent. (See pl. XIV., fig. 7).

Seeds 6–10 per fruit, elliptical-ovate, or rather flattened ; testa brown, transversely striated, outer layer peels off readily ; endosperm strongly ruminate ; 23 mm. long, 15 mm. wide, 6 mm. thick ; embryo white, 15 mm. long. (See pl. XIV., fig. 9–10).

Seedlings epigeal; cotyledons not readily detached but never function as assimilatory organs and exist as white or shrivelled leaves for a few days; by the time the cotyledons are dead the enhanced epicotyledonary leaves are deep green and well developed (*cf.* D. Thwaitesii).

Cotyledons white, 13 mm. long; *hypocotyl* white, glabrous, 90 mm. long; *epicotyledonary* stem greenish, hairy, 3 mm. long; epicotyledonary leaves form an opposite pair, ovate, rounded apex, rounded or tapering base, glabrous, 50 mm. long, 25 mm. broad; *traces* 3 per cotyledon, xylem of median trace weak, xylem of lateral cotyledonary traces much split; one trace per epicotyledonary leaf, weak and continued into root.

Timber.—A typical red wood with occasional small black strands; black heartwood absent or small; the elements are feebly lignified, even the fibres; vessels have rather large transverse dimensions. The colouring substances are not very abundant. The timber is much inferior to ebony but superior to the yellow and white woods already described. It is rarely felled even where very abundant, and most natives disregard it entirely as a source of durable timber.

Distribution.—Moist lowcountry, rather rare, Kalutara, Hewessa, Penijaval Forests, Kadawatte, Hinidumkanda, near Galle. It grows well in poor sandy or rocky soils providing there is plenty of water; in some districts it can only be found alongside the streams with roots occasionally submerged; often accompanies D. Embryopteris and D. quæsita in moist low-country.

Endemic.

The habit of D. Moonii is very different from that of D. hirsuta or D. Thwaitesii, and in this respect greatly resembles D. Embryopteris; the fleshy leaves resemble those of D. acuta; the flat relatively thin fruiting calyx and the large globose fruits are widely different from anything met with in D. hirsuta or D. Thwaitesii. D. Thwaitesii resembles D. hirsuta in many features, but can always be distinguished from it in virtue of its 4-celled ovary, larger number of stamens, thinner and smaller leaves.

The three species have therefore been described separately.

19. **Diospyros affinis,** Thw. Enum. Ceyl. Pl., p. 179, n. 6 (1860).

Kaluwella (Viriniya), Semel Panachai, S.

Fl. B. Ind. III., 566. C. P. 2,924. Hiern, Mon. Eben. 169. Bedd. Ic. Fl. Ind. Or. t. 127 (1871).

A moderate-sized or large tree, evergreen, diœcious and polygamous; young twigs green and slightly pubescent, older twigs brown to black and shiny; bark of young branches thick, alternate longitudinal grey and black layers, 10 mm. wide and 40–80 mm. long. In old trees the grey layer becomes the fissure and the dark layer the ridge. The fissures becomes very large and characteristic of the bark. The bark peels away in irregular thick patches.

Leaves alternate, 35–90 mm. long, 13–30 mm. wide, oval or oblong, tapering towards apex, apex obtuse, narrowed at base, glabrous, coriaceous; venation reticulate, meshes wide, not strongly pellucid, net veins rather prominent beneath; *petiole* flattened above, 10 mm. long, 1–5 mm. diameter.

Flowers in June–August; ripe fruits June-October.

The polygamous condition is very frequent. At Viriniya in June, 1902, I obtained abundance of ripe fruit from polygamous trees of this species. The fruits were a trifle smaller than those obtained from true female trees. The hermaphrodite flowers only differ from the male flowers on the same tree in having larger calyces and a fertile pistil, the number and nature of stamens being the same. The hermaphrodite flower when occurring alone on a male cyme usually occupies the position of the median and oldest flower (*cf.* D. oppositifolia). In other cases the majority of the flowers of a particular cyme are hermaphrodite. (See pl. X., fig. 5).

I have also found the polygamous condition on a tree in the Peradeniya Gardens in March, 1903; this particular tree had not been in flower for at least the last three years.

The male inflorescence consists of cymose cluster of 3–7 flowers in axil of caducous bract or foliage leaf. The peduncle is green, hairy, 10 mm. long, 2 mm. diameter. The pedicels vary in length from 2–4 mm., diameter 2 mm.; bracts green, hairy, caducous, 12 mm. long; bracteoles of lateral flowers 9 mm. in length, long tapering apices, green and glabrous, gradually decreasing in size from below upwards, those subtending the ultimate pedicels being very small.

Calyx green, tubular, glabrous, 7 mm. long, 2·5 mm. diameter; segments 4, variable length, apex acute.

Corolla yellowish-white, length 12 mm., average diameter 3 mm.; segments 4, hairy outside, acute apex, broad base, 4 mm. long.

Stamens 6–9–16, forming central hypogynous ring, in pairs or single; *anthers* reddish-brown, glabrous, slightly apiculate, 3–4 mm. long; *filaments* white, glabrous, 1 mm. long; *pollen* circular, yellow.

Pistil rudimentary, represented by a bunch of hairs.

Female flowers solitary on stout peduncles. Peduncles green, nearly glabrous, 5–10 mm. long, 2·5 mm, diameter; pair at right angles to antero-posterior axis near base of flower suggesting a cyme with abortive lateral flowers (*cf.* D. Gardneri); bracteoles caducous, very small. (See pl. X., fig. 1).

Calyx green, hairy inside, sub-glabrate outside, 13 mm. long; segments 4, tapering apex, 10 mm. long, undulating margin, conspicuous intersegmental pouch.

Corolla yellowish-white, tubular; segments 4, short.

Staminodes 6–8, epipetalous at base of corolla or part hypogynous, glabrous, barren anthers.

Pistil green; styles two, each bifid at apex; ovary usually 6-celled, occasionally 8-celled, when latter the loculi are opposite and alternate to calyx lobes, when former four loculi alternate with calyx lobes, the other two taking up any position.

Fruit green or yellow when ripe, globose, slightly apiculate, becomes glabrous, 30 mm. diameter, 25 mm. long; fruiting calyx enlarged, 30 mm. diameter, rather flattened with segments glabrous, black, apices in contact with carpellary wall, margins reflexed, intersegmental pouch large.

Seeds usually 4, ovate, wedge shaped, 18 mm. long, 11 mm. wide, 7 mm. thick; testa deep brown; endosperm copious and ruminate.

Seedlings epigeal, cotyledons detached early, epicotyledonary system well developed before detachment of cotyledons occurs; *cotyledons* white, 11 mm. long, ovate, apex obtuse; *hypocotyl* white, 7 cm. long; *epicotyledonary* stem reddish, pubescent, 4 mm. long; *epicotyledonary* leaves form an opposite pair, ovate, tapering towards base, apex tapering, obtuse; venation reticulate; 35 mm. long, 20 mm. wide; *traces* 3 per cotyledon, fairly equal in strength, xylem of lateral strands split to varying degrees; one epicotyledonary trace per leaf, continued into hypocotyl and root.

Timber.—The coloured heartwood is usually small but occasionally very good; one tree measuring 24·4 metres high (80 feet) and nearly 2 metres circumference, (6½ feet) possessed a small black heartwood only 100 mm. (4 inches) diameter; in some specimens much smaller than the foregoing the heartwood was large, streaked brown, and probably sold as "bastard" ebony; such samples are often equal to our best woods from an ornamental point of view (*cf.* D. oocarpa). (See pl. I., fig. 4).

The colouring matter is very abundant even in the sapwood; the fibres are very high in percentage number, and possess narrow lumina.

Rings of growth are inconspicuous.

Distribution.—dry and intermediate zones, rather rare; between Uma-oya and Bilihul-oya on the lower Badulla road from Kandy; Viriniya, near Bibile; Bintenna, Kantalai, Kalugalla, Vavuniya.

Also in Tinnevelly, S. India.

20. **Diospyros crumenata,** Thw. Enum. Ceyl. Pl., p. 179, n. 5 (1860). Fl. B. Ind. III., 567. C. P. 2,438. Hiern, Mon. Eben, 169. Bedd. Ic. Pl. Ind. Or. Part VII., p. 26, t. 126 (1871).

A large evergreen tree, diœcious; bark thick, black, rather scaly; trunk erect, twigs glabrous.

Leaves alternate, 50–120 mm. long, 25–50 mm. wide, oval-oblong, abruptly acuminate apex, rounded or narrowed at base, glabrous and shining, coriaceous, pellucid venation, net veins rather prominent; *petiole* canaliculate above, 6–10 mm. long. Flowers March-August; ripe fruits January-October.

Male inflorescence consists of a pedicellate spreading cyme of 3–7 flowers. (See pl. VIII., fig. 1.)

Flowers yellow, 15 mm. long, throat 4 mm. diameter, top of open flower 11 mm. diameter. Peduncle 3–10 mm. long, green, hairy; ultimate pedicels 1-4 mm. long.

Calyx green, cupuliform, 5–10 mm. long, glabrous inside; segments 4, short or obscure.

Corolla yellow, tubular, 14 mm. long; segments 4, short, rounded apices, broad and recurved in open flower.

Stamens 8-14, hypogynous, 4–6 mm. long; *anthers* brown or yellow, attenuate, glabrous, 4–5 mm. long; *filaments* white, glabrous, 1 mm. long, sometimes absent; *pollen* yellow, circular. (See pl. VIII., fig. 2.)

Pistil absent or rudimentary.

Female flowers solitary, in axil of foliage leaves and usually limited to the lower part of young shoot; approximately spherical in bud, measuring 9 mm. diameter. Peduncle 5–10 mm. long, 2–5 mm. diameter; two or more small caducous bracteoles occur on the peduncle, the first two forming an opposite pair at right angles to antero-posterior axis (cf. D. affinis). (See pl. VIII., fig. 3.)

Calyx green, under surface hairy; segments 4, accrescent in flower, acute apex; margin becomes reflexed, and deep intersegmental pouches are formed after the flower has opened.

Corolla yellowish-white, 15 mm. high, tubular, throat somewhat constricted, basal part swollen ; segments 4, rotate, rounded apices, undulated margins, tomentose on both sides.

Staminodes 8, epipetalous, opposite and alternate with corolla segments, 3 mm. long ; *anthers* barren, glabrous, not apiculate but apex shows signs of bifurcation ; *filaments* white and glabrous. (See pl. VIII., fig. 4.)

Pistil greenish-yellow, pubescent ; stigmas 4, fleshy, short ; ovary 8-celled.

Fruit green, 25–40 mm. diameter, 40 mm. long, depressed-globose, apiculate, glabrous or nearly so ; 8-celled, loculi opposite and alternate with calyx segments. (See pl. VIII., fig. 5.)

Fruiting calyx enlarged, woody, flattened, intersegmental areas are straightened and outline of calyx is tetrahedral (cf. D. insignis).

Seeds 1–8 in each fruit, flattened and elliptical, 45 mm. long, 20 mm. wide, 11 mm. thick ; testa umber-brown, shining ; endosperm copious, ruminate ; embryo white, 24 mm. long.

Seedlings epigeal, cotyledons detached early, epicotyledonary axis well developed ; *cotyledons* white, feebly petiolate, 16 mm. long, 7 mm. wide ; *hypocotyl* white and cylindrical, changing to black and four cornered, 110 mm. long, 3 mm. diameter ; *epicotyledonary* stem red, hairy, 15 mm. long ; traces 3 per cotyledon, much splitting of xylem in collet area ; one epicotyledonary trace per leaf —continued into root, rarely shows splitting of xylem.

Timber.—This is of medium quality and belongs to the red kind. The red colour intensifies from without inwards and local black strands occur here and there. The coloured heartwood is not usually large ; some specimens, however, yield a large black and brown streaked heartwood of considerable beauty and value. The sapwood is much less durable than the heartwood, in consequence of the wide

lumined tracheal and parenchymatous elements there existing. The heartwood contains a fair percentage of fibres of narrow lumen. Trees of this species are certainly worth a little attention, judging from many excellent specimens which I have seen at Ambalawa, near Gampola.

Distribution.—Endemic and rare, limited to moist region, 1,500–4,000 feet ; Deltota, Uduwella, below Haputale, Hantane, Gangaruwa, Kalugalla, Ambalawa.

KEYS TO THE CEYLON SPECIES OF DIOSPYROS.

General Characters.

The following key is based on the general characters of the leaves, fruits, and stems, and may be found useful as a substitute for that given by Trimen. With the help of this key and the illustrations of every species showing flowers, fruits, seeds, timber, and leaves there ought to be no difficulty in identifying species of Diospyros in the forests of Ceylon.

ENDOSPERM EQUABLE.

Leaves large, 110 to 300 mm. long.

Fruit flattened or ovoid-globose, covered with glandular hairs ... **D. Embryopteris.**

Fruit attenuate, feebly pubescent... **D. acuta.**

Leaves 50–200 mm. long.

Leaves opposite ... ... **D. oppositifolia.**

Leaves alternate.

Leaves thin, not coriaceous, feebly pellucid.

Fruit depressed-globose, stem spiny ... **D. montana.**

Fruit strongly attenuate, stem smooth ... **D. attenuata.**

Leaves coriaceous, strongly pellucid venation.

Seeds flat.

Fruits depressed-globose, leaves bullate and pellucid ... 9. **D. Gardneri.**

Fruit globose-ovoid, nervation not pellucid ... 11. **D. quæsita.**

Seeds wedge-shaped.

Nervation closely reticulate, fruit-calyx thin and flat ... 4. **D. Toposia.**

Nervation wider mesh, fruit-calyx woody and cup-shaped ... ... 5. **D. Ebenum.**

Leaves small, 50–120 mm. long.

Leaves and fruits covered with very long hairs ... ... 6. **D. pruriens.**

Leaves and fruits glabrous.

Veins and calyx segments inconspicuous, seeds deeply grooved ... .. 10. **D. oocarpa.**

Veins and calyx segments conspicuous, seeds superficially striated ... ... 1. **D. ovalifolia.**

ENDOSPERM RUMINATE.

Male corolla urceolate, seeds small and rounded ... .. 12. **D. sylvatica.**

Male corolla tubular, seeds wedge-shaped or flat.

Leaves large, 100–300 mm. long.

Fleshy, veins not prominent, bark thick[1] ... 18. **D. Moonii.**

Coriaceous, veins prominent, bark thin and scaly ... 15. **D. insignis.**

Leaves 35–130 mm. long.

Mature fruit hairy ... **D. hirsuta.**

Mature fruit glabrous or nearly so.

* Fruit-calyx much enlarged and woody.

† Leaves oblong-oval, 40–90 mm. long, feebly pellucid venation ... **D. affinis.**

†† Leaves with acuminate apex, 50–130 mm. long, pellucid venation ... **D. crumenata.**

** Fruit-calyx not much enlarged nor woody.

† Fruit globose, 35 mm. high, leaves broadly oval ... **D. Melanoxylon.**

†† Fruit broadly ovoid, 25 mm. high, leaves narrowly lanceolate ... **D. Thwaitesii.**

Seedling and Fruit Characters.

The following key has been constructed mainly from characters of the seeds and seedlings. In several instances the number and behaviour of cotyledonary traces would have been of service, but as such characters cannot be used outside the laboratory those of the fruit have been included as being of more practical importance in determining the identity of species in the forest.

ENDOSPERM EQUABLE.

Cotyledons persistent.

Seeds flat, thin (2 mm.) ... **D. Gardneri.**

Seeds wedge-shaped.

Fruit-calyx large, woody, segments acute, first epicotyledonary leaf small, only 2 mm. long **D. Ebenum.**

Fruit-calyx small, thin, segments rounded, first epicotyl leaf average size, 20 mm. long 2. D. montana.

Cotyledons dropping.

Hypocotyls short (10-50 mm.), epicotyledonary stems long (40-70 mm.).

Seeds irregular in shape, deeply grooved, hypocotyl 10-30 mm., fruit—calyx segments undistinguishable ... ..12. D. oocarpa.

Seeds oval - elliptical or wedge-shaped, hypocotyl 40-50 mm. long ...4. D. Toposia.

Hypocotyl long (30-100 mm.), epicotyledonary stems short (3-40 mm.).

Seedlings densely pubescent 6. D. pruriens.

Seedling glabrous or nearly so.

* Seeds rounded and short (9 mm.), testa superficially striated ...1. D. ovalifolia.

** Seeds large and flat, 30 mm. long.

Testa transversely striated, epicotyledonary leaves opposite ...11. D. quæsita.

Testa not striated, epicotyledonary leaves sub-opposite ...3. D. Embryopteris.

*** Seeds semi-lunar or wedge-shaped.

Seeds acuminate at micropyle, fruit-calyx large and convolute ...8. **D. acuta.**

Seeds not acuminate, fruit-calyx small and thin ...7. **D. attenuata.**

Fruit-calyx forms deep cup (18 mm.) ...16. **D. oppositifolia.**

ENDOSPERM RUMINATE.

Cotyledons persistent.

Seeds short (14 mm.), globular ...12. **D. sylvatica.**

Cotyledons dropping.

Hypocotyl short (15 to 20 mm.), epicotyledonary stem long, with leaf rudiments (65 mm.) ...15. **D. insignis.**

Hypocotyls long (60-110 mm.), epicotyledonary stem short (3–15 mm.).

Fruits small, 27 × 23 mm.

Fruit wall with dense layer of brown hairs, fruit 8-celled ...14. **D. hirsuta.**

Fruit wall when old nearly glabrous, fruit 4-celled ..17. **D. Thwaitesii.**

Fruit large, 36 × 33 mm.

Seeds flat and thin.

Testa deeply striated, fruit-calyx small, thin ..18. **D. Moonii.**

Fruit-calyx large, woody, strongly recurved ..20. **D. crumenata.**

Seeds wedge-shaped or semi-lunar.

Fruits globular, fruit-calyx large, thick, and undulate 13. **D. Melanoxylon.**

Fruits apiculate or flattened at top, fruit-calyx thin and small ...19. **D. affinis.**

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Description of Plates I—XX.

Plate I.—Sections of the timber of (1) *D. pruriens*, (2) *D. hirsuta*, (3) *D. Moonii*, (4) *D. affinis*, (5) *D. Melanoxylon*, and (6) *D. ovalifolia*.

The relative sizes of the different trees may be calculated from the measure photographed on Plate V. Obviously, the timber of most of the species here described may be obtained in various sizes, but those on the same plate are selected with a view to illustrating the relative sizes of mature trees of the respective species.

Plate II.—Transverse sections of the timber of (7) *D. sylvatica*, (8) *D. oppositifolia*, and (9) *D. Thwaitesii*.

Figure 8 shows the characteristic hollow decaying protoxylem area and the streaked nature of the remaining wood in D. oppositifolia. The rings of growth in D. sylvatica are perhaps clearer than in any other Diospyros species.

Plate III.—Transverse sections of the timber of (10) *D. attenuata* (12) *D. Toposia*, (13) *D. insignis*, with characteristic bark, and (11) oblique section and log of *D. acuta* showing bark characteristic of most Diospyros species.

Plate IV.—Transverse sections of (14) *D. crumenata*, (15) *D. oocarpa*, and (16) *D. Ebenum*.

The section of D. oocarpa is unusually large and is used to show the large amount of streaked ebony of good quality which is frequently found in this species.

Plate V.—Longitudinal section of (17) *D. quæsita* showing streaked heartwood of varying width, transverse section of (18) *D. Gardneri*, longitudinal and oblique sections of (19) *D. Montana*, and (20) *D. Embryopteris.*

Plate VI.—Nat. size. *(1-4), D. oppositifolia* ; (1) female flower terminating young twig ; (2) mature fruit and fruiting calyx ; (3) and (4) male inflorescence and flowers from woody twig ; *(5-9) D. quæsita* ; (5) female flowers, young and mature ; (6) seed showing transverse striæ on testa and young seedling stage ; (7) male inflorescences : (8) fruit in longitudinal section (reduced ½); (9) longitudinal section of seed showing embryo *in situ.*

Plate VII.—Nat. size. *(1-7), D. oocarpa* ; (1) male inflorescences ; (2) section through male flower, showing position of stamens ; (3) mature male flower showing calyx with insignificant segments ; (4) female flower ; (5) fruit showing insignificant straight rimmed calyx ; (6) seed; (7) leaf. *(8-14), D. acuta* ; (8) male inflorescence ; (9) corolla of male flower ; (10) female inflorescence ; (11) solitary female flower ; (12) corolla of female flower ; (13) fruit with calyx ; (14) pistil from mature flower.

Plate VIII.—Nat. size, except (2) and (4).

1-5, D. crumenata ; (1) male inflorescence ; (2) section of male flower enlarged to show position of stamens ; from drawings in the herbarium ; (3) solitary female flower ; (4) dissected corolla of female flower showing position of staminodes (enlarged); from herbarium drawing ; (5) fruit and recurved fruiting calyx ; *(6-9) D. Melanoxylon* ; (6) female inflorescences ; (7) fruits ; (8) male inflorescences ; (9) male flower.

Plate IX.—Nat. size. *D. Embryopteris.* 1, 2, 3, 4, stages in the development of the female inflorescence showing positions of bracts (for description see Part 1, p. 72); (5) mature female inflorescence ; (6) fruit covered with reddish-brown glandular and unicellular hairs ; 7, 8, 9, and 10 stages in the development of male inflorescence ; described in Part 1, p. 73–74 ; (11) mature male inflorescence ; 12 section through male flower showing position of stamens.

Plate X.—Nat. size, except 4 and 10. *1-6, D. affinis* ; (1) mature female flower ; (2) fruit showing insignificant calyx ; (3) male inflorescences showing positions of detached flowers; (4) section through male flower showing position of stamens and rudimentary pistil enlarged ; from herbarium drawing ; (5) polygamous inflorescence, median female, and lateral male flowers ; (6) fruit from polygamous tree ; *7-10, D. Toposia* ; (7) young and (8) mature male inflorescences ; (9) female inflorescence ; (10) fruit, young, ½ size of mature specimens.

Plate XI.—Nat. size. *1-9*, *D. sylvatica* ; (1) young male (2) mature male inflorescences ; (3) corolla of male flower dissected to show position of stamens ; (4) polygamous twig bearing upper cluster of male flowers and fruit below ; (5) and (6) sections through flowers from polygamous tree showing development of pistil ; (7) seed showing external rumination ; (8) female inflorescences ; (9) fruit from female tree. *10-15*, *D. attenuata* ; (10) male inflorescence ; (11) separate male flower ; (12) seed ; (13) mature fruit showing insignificant calyx ; (14) solitary female flower ; (15) leaf.

Plate XII. D. Gardneri. Nat. size, except 2 and 10 ; (1) group of hermaphrodite flowers from polygamous tree ; (2) × ½ section of hermaphrodite flower showing pistil and stamens ; (3) male flower ; (4) section of male flower ; (5) male inflorescense ; (6) male flowers and fruit on same twig from polygamous tree ; (7) flower from true male tree ; (8) section of male flower showing stamens ; (9) corolla of male flower dissected to show position of 8 pairs of epipetalous stamens; (10) ring of stamens (enlarged) to show groups of various sizes, from herbarium drawing ; (11) solitary female flower ; (12) section through female flower showing staminodes and pistil ; (13) corolla of female flower dissected to show the position of eight epipetalous staminodes ; (14) longitudinal section of seed showing equable endosperm and embryo *in situ.*

Plate XIII.—Nat. size.

D. Ebenum1-8. (1) Male flowers ; (2) female cymose inflorescence ; (3) solitary female flowers ; (4) polygamous clusters (*a*) female (*b*) male flowers ; (5) monœcious group (*a*) female (*b*) male flowers ; (6) group of stamens showing fusion and unequal length ; (7) fruit and recurved calyx ; (8) transverse section of young fruit.

D. pruriens (*9–12*). (9) Male flowers and leaves ; (10) staminal whorl magnified ; (11) fruit with long hairs ; (12) seed with embryo.

Plate XIV.—Nat. size.

D. insignis (*1–5*). (1) Male flowers ; (2) polygamous flowers (*a*) female flower ; (*b*) same flower separated from cluster ; (3) female flowers in bud ; (4) fruit with calyx ; (5) L. S. of seed with embryo and showing ruminate endosperm.

D. Moonii (*6–10*). (6) Young fruits ; (7) male flowers in bud ; (8) fruit with calyx ; (9) seed showing transverse striæ ; (10) longitudinal section of seed to show embryo and ruminate endosperm.

Plate XV.—Nat. size except 4 and 5 which were taken from drawings in the herbarium.

D. ovalifolia (*1–5*). (1) Male inflorescence ; (2) female flowers, fruit, and leaf ; (3) seed showing irregular striæ ; (4) pistil in situ,

corolla, and staminodes removed ; (5) pistil figured from above to show crenate bifid stigma.

D. hirsuta (*6-12*). (6) Male inflorescence ; (7) female inflorescence; (8) polygamous group (*a*) female flower ; (*b*) male flowers ; (9) monœcious group (*a*) female ; (*b*) male ; (10) fruit and calyx ; (11) seeds exposed after carpellary wall removed ; (12) longitudinal section of seed showing embryo.

Plate XVI.—Nat. size.

D. Thwaitesii (*1-6*). (1) Male flowers ; (2) female flowers ; (3) polygamous group (*a*) female (*b*) male flowers ; (4) monœcious state (*a*) female (*b*) male cluster ; (5) fruit and calyx ; (6) young seedling.

D. montana (*7-10*). (7) fruits and leaf ; (8) section through fruit showing seeds and embryos *in situ ;* (9) male flower ; (10) female inflorescence.

Plate XVII.—Nat. size.

D. insignis (*1-3*). (1) Germinated seed representing a stage of the seedling when the cotyledons are detached, but the epicotyledonary system not liberated ; (2) a later stage showing the hypocotyl less than one cm. in length and young epicotyledonary stem ; (3) an old seedling showing short hypocotyl, long epicotyledonary stem with rudimentary leaves along its length and a pair of large leaves at the apex.

D. Toposia. (4) Seedling showing median length for hypocotyl and long epicotyledonary stem without leaf rudiments.

D. sylvatica (*5-6*). (5) young seedling ; (6) mature seedling with long hypocotyl and a pair of persistent foliaceous cotyledons. Note the absence of epicotyledonary leaves.

The first pair of leaves in the seedlings of these three species are approximately the same height above the ground.

Plate XVIII.—Nat. size except 6 to 8.

D. pruriens (*1-5*). (1) Seed showing embryo ; (2) young seedling ; (3) seedling with white cotyledons attached at cotyledonary node ; (4) stage showing the shrivelled cotyledons after a few hours' exposure and the enhanced epicotyledonary leaves ; (5) mature seedling showing cotyledons detached and a scar at the cotyledonary node, an epicotyledonary stem about one cm. in length, and the first pair of epicotyledonary leaves as an opposite pair similar to the cotyledons of D. sylvatica.

Embryos (*6-8*). (6) D. crumenata (× 2) ; (7) D. Embryopteris (× 2) ; (8) D. Ebenum (× 2) ; (9) seedling of D. Embryopteris showing the pale cotyledons prior to being detached and just exposed by removal of the testa and endosperm ; note the long epicotyledonary hairy stem between cotyledons. (cf. fig 6, pl. XVII.)

Plate XIX.—(All 4 × D.).

Sclerotic cells (1–4). (1) From cortex of a twig 0·9 mm. diameter ; (2) from twig 2 mm. diameter ; (3) from branch 70 mm. diameter ; (4) from branch 78 mm. diameter.

Hairs (5–10). (5) Origin of unicellular hairs from upper surface of calyx, D. Ebenum ; (6) pedicellate multicellular gland, from upper surface of calyx, D. Ebenum ; (7 and 8) irregular unicellular hairs from leaf bud D. Embryopteris ; (9 and 10) multicellular glands usually on long pedicels, from carpellary wall of fruits of D. Embryopteris.

Plate XX.

D. Ebenum (1–6). (1) Transverse section of xylem, D × 4 ; (2) transverse section of twig 2 mm. diameter showing origin of phellogen from subepidermal layer ; (3) section, diagramatic, of old xylem with lumina filled with coloured material ; (4) rods of black carbon-like material liberated from the cells after treatment with strong sulphuric acid ; (5 and 6), sections of the xylem showing the appearance of the deposits in the early stages ; transverse and longitudinal.

Correction.

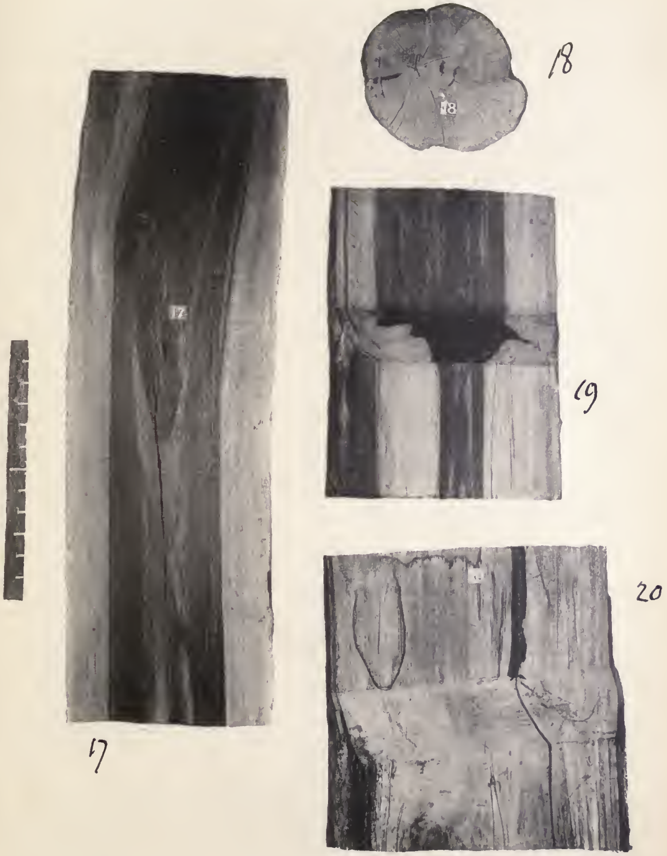
In Cooke's Flora of the Bombay Presidency, Vol. II., Pt. 1, received since the above was completed, D. crumenata is given as common in the forests between Gairsoppa and Dodmune Ghâts. It is therefore not endemic in Ceylon, as stated on p. 199. 67.

D. PRURIENS (1), D. HIRSUTA (2), D. MOONII (3), D. AFFINIS (4)
D. MELANOXYLON (5), D. OVALIFOLIA (6)

D. SYLVATICA (7), D. OPPOSITIFOLIA (8), D. THWAITESII (9)

D. ATTENUATA (10), D. ACUTA (11), D. TOPOSIA (12), D. INSIGNIS (13)

D. CRUMENATA (14), D. OOCARPA (15), D. EBENUM (16)

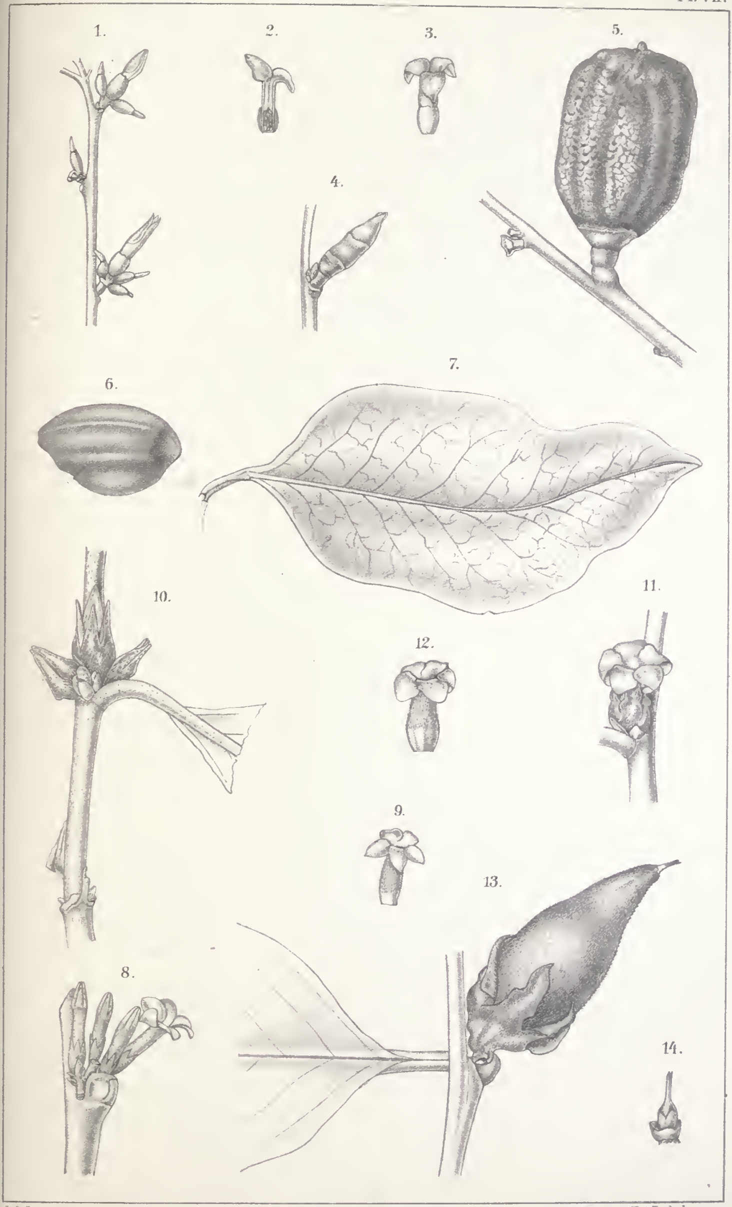


D. QUAESITA (17), D. GARDNERI (18), D. MONTANA (19)
D. EMBRYOPTERIS (20)

W. de Alwis et H.W. del

Lith Anst.v.E. A Funke Leipzig

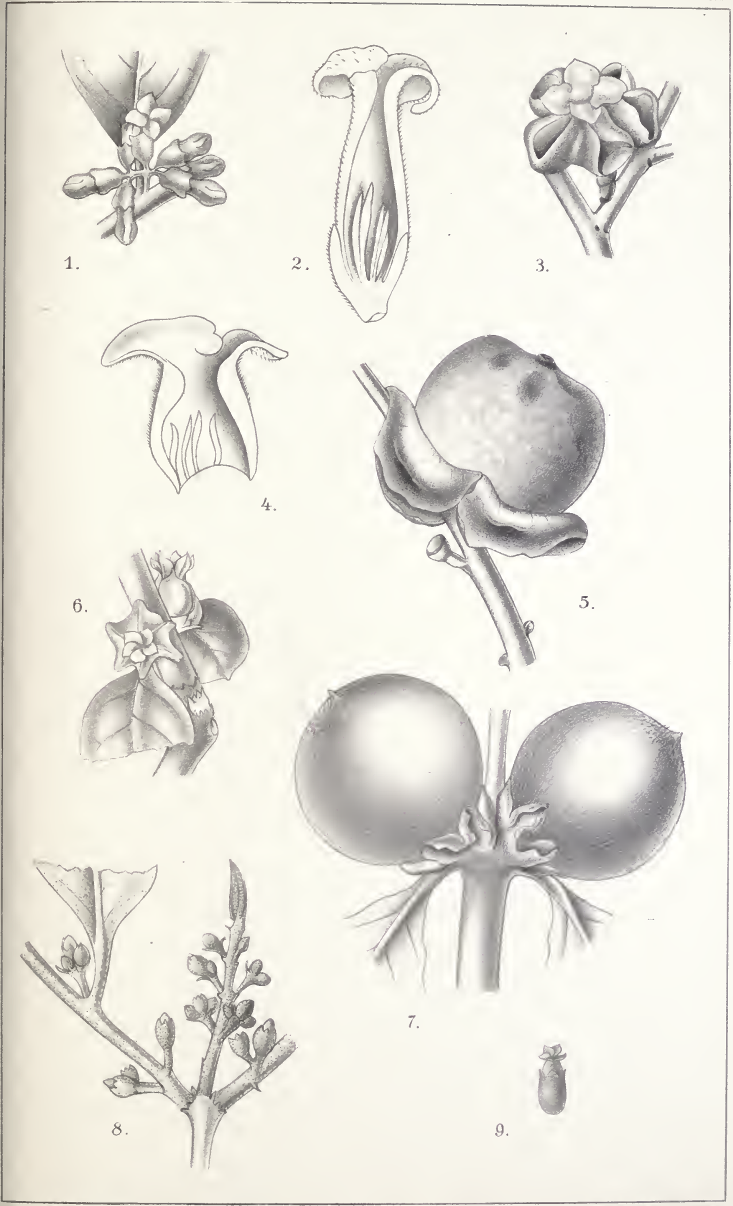
D. OPPOSITIFOLIA, (1-4) D. QUAESITA (5-9).



W. de A[illegible] et H W del

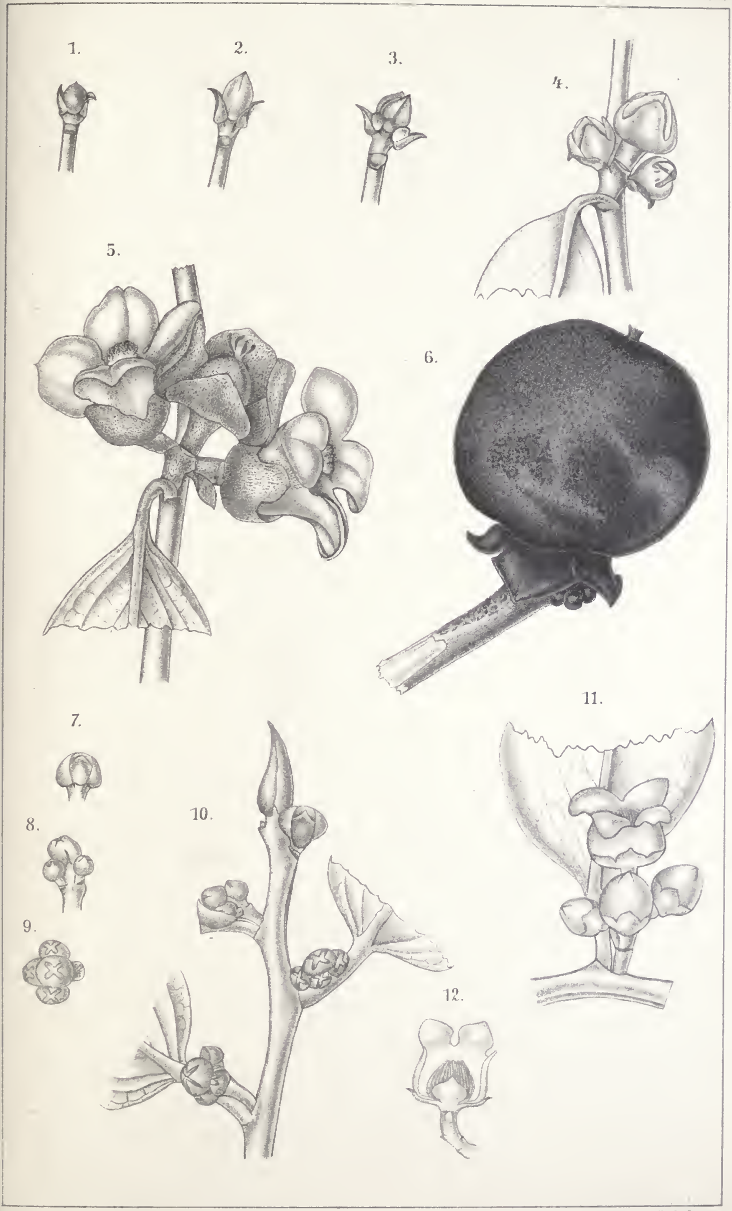
Lith. Anst. v. E. A. Funke, Leipzig

D. OOCARPA (1-7); D. ACUTA (8-14).



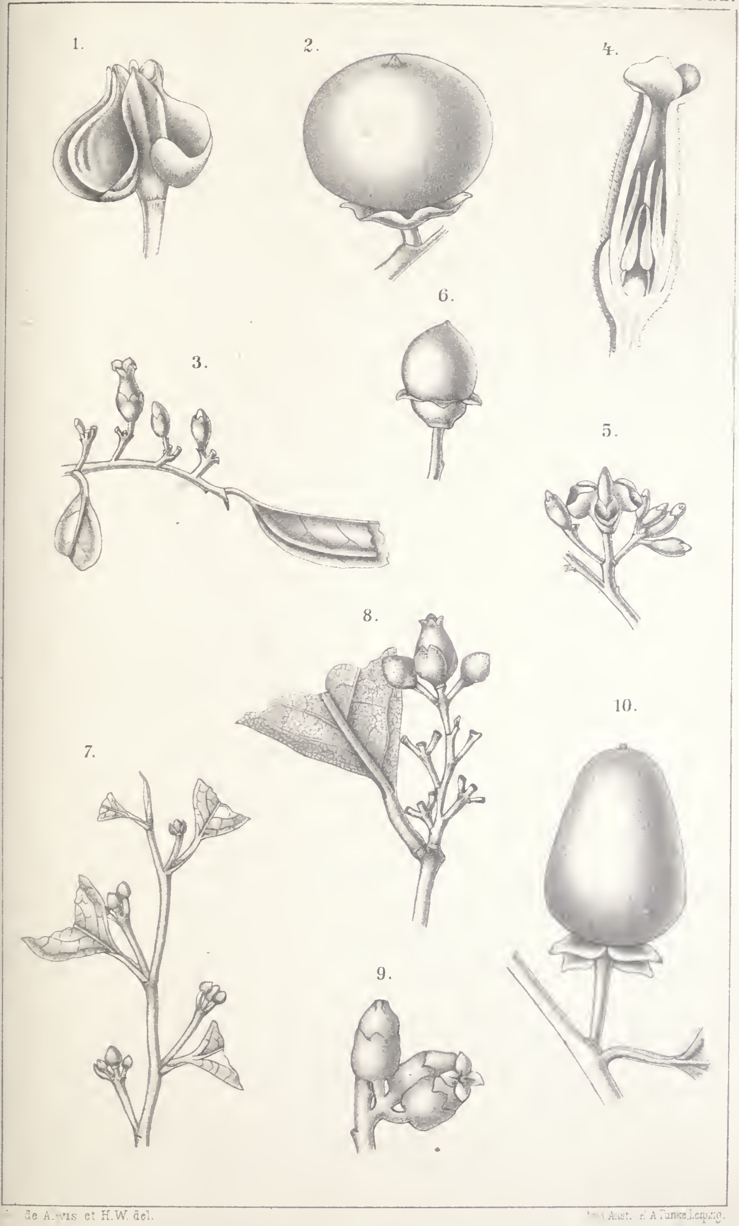
de A[illegible] et H. [illegible] del.　　　Lith. Anst. v. [illegible] Funke [illegible]

D. CRUMENATA (1-5), D. MELANOXYLON (6-9).



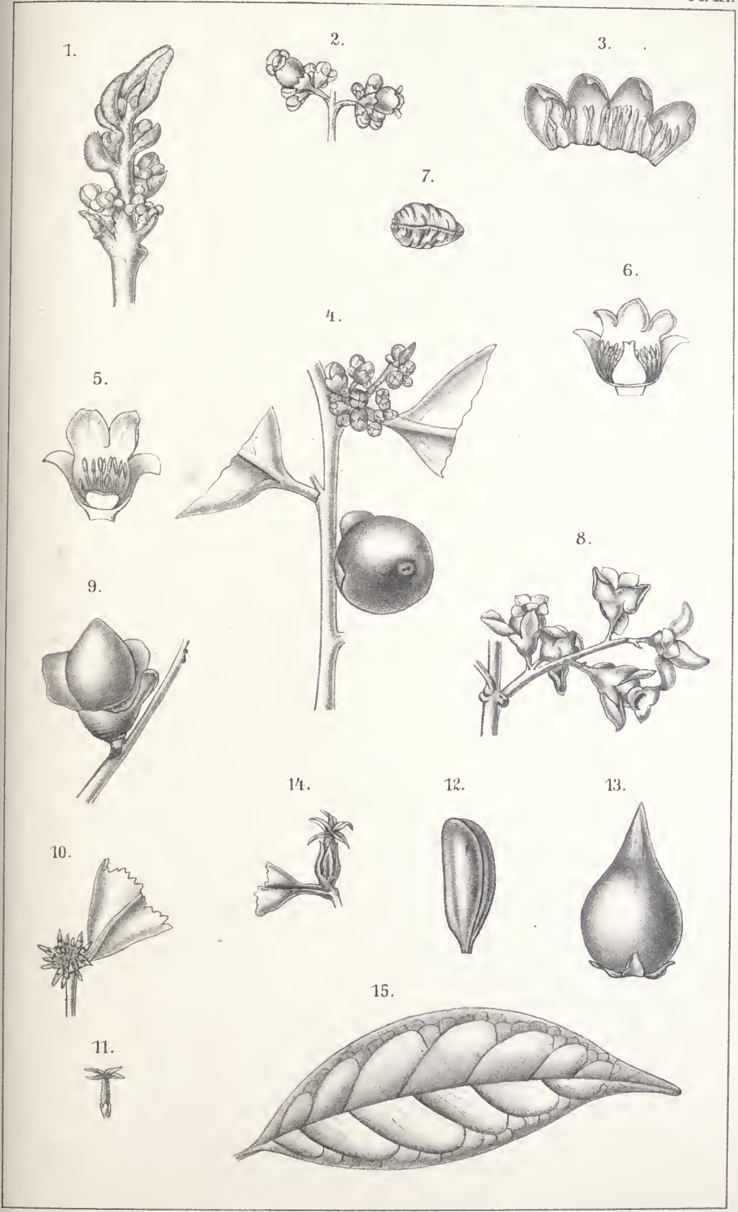
W de Alwis et H.W del. Lith Anst. v E. A. Funke, Leipzig.

D. EMBRYOPTERIS (1-12).



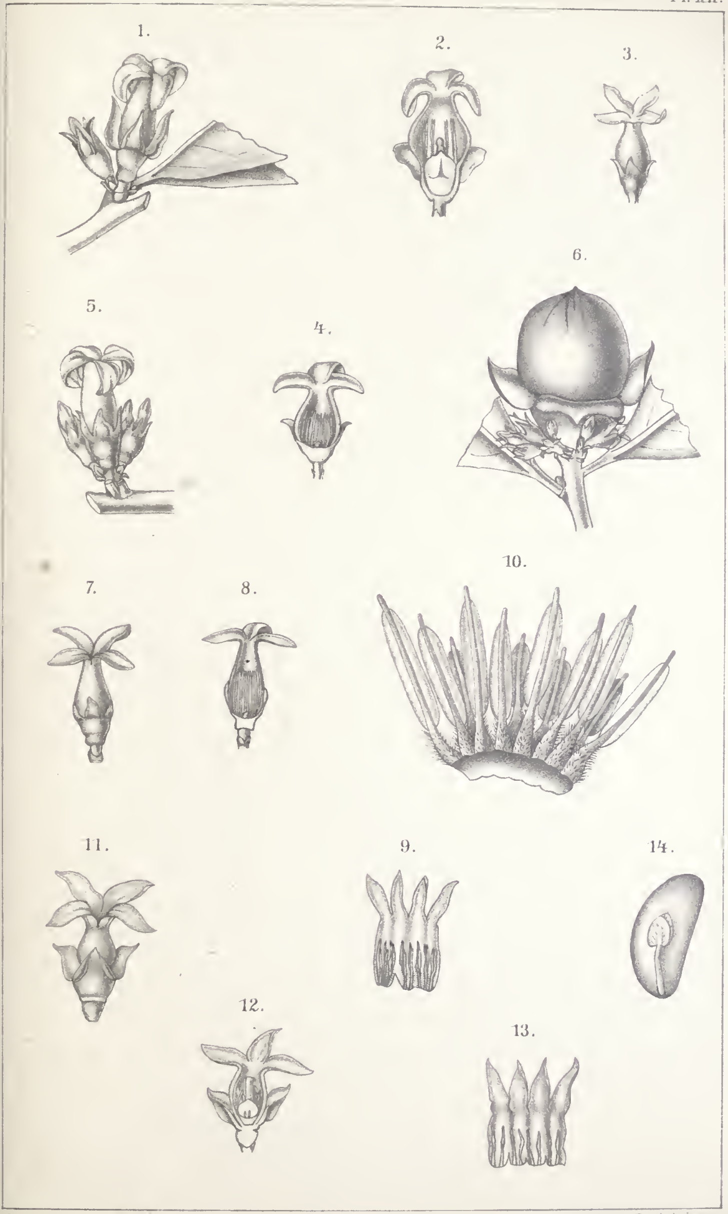
de A. ..vis et H.W. del. ... Anst. v. A. Funke, Leipzig.

D. AFFINIS (1-6), D. TOPOSIA (7-10).



W. de Alwis et H.W. del. Lith. Anst. v. E. A. Funke, Leipzig

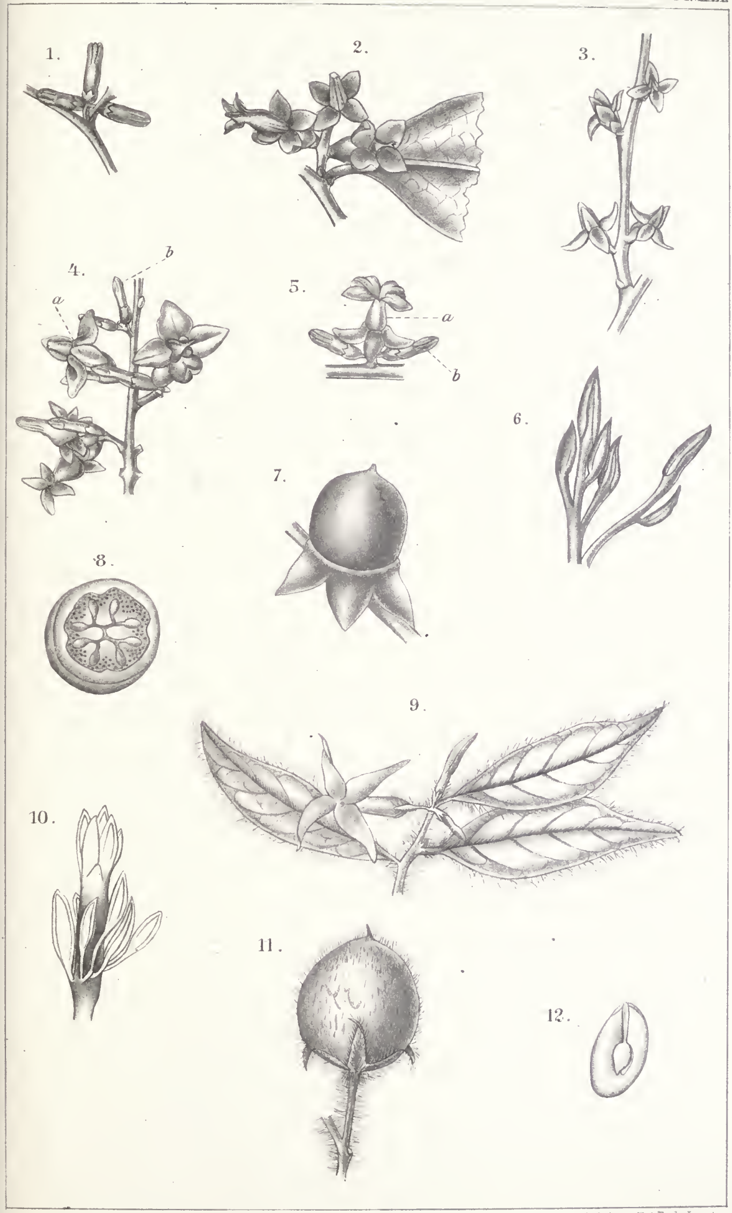
D. SYLVATICA (1-9); D. ATTENUATA (10-15).



de Alwis et H. del.

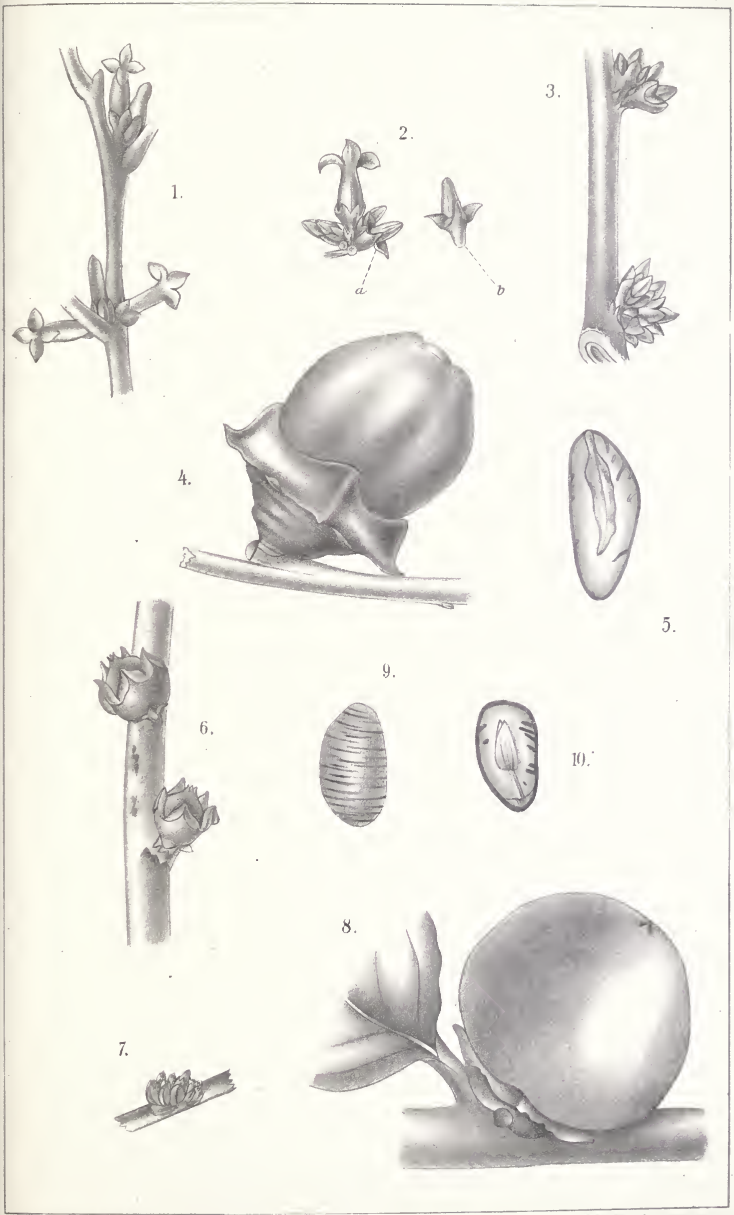
Anst. v E. A. Funke

D. GARDNERI.

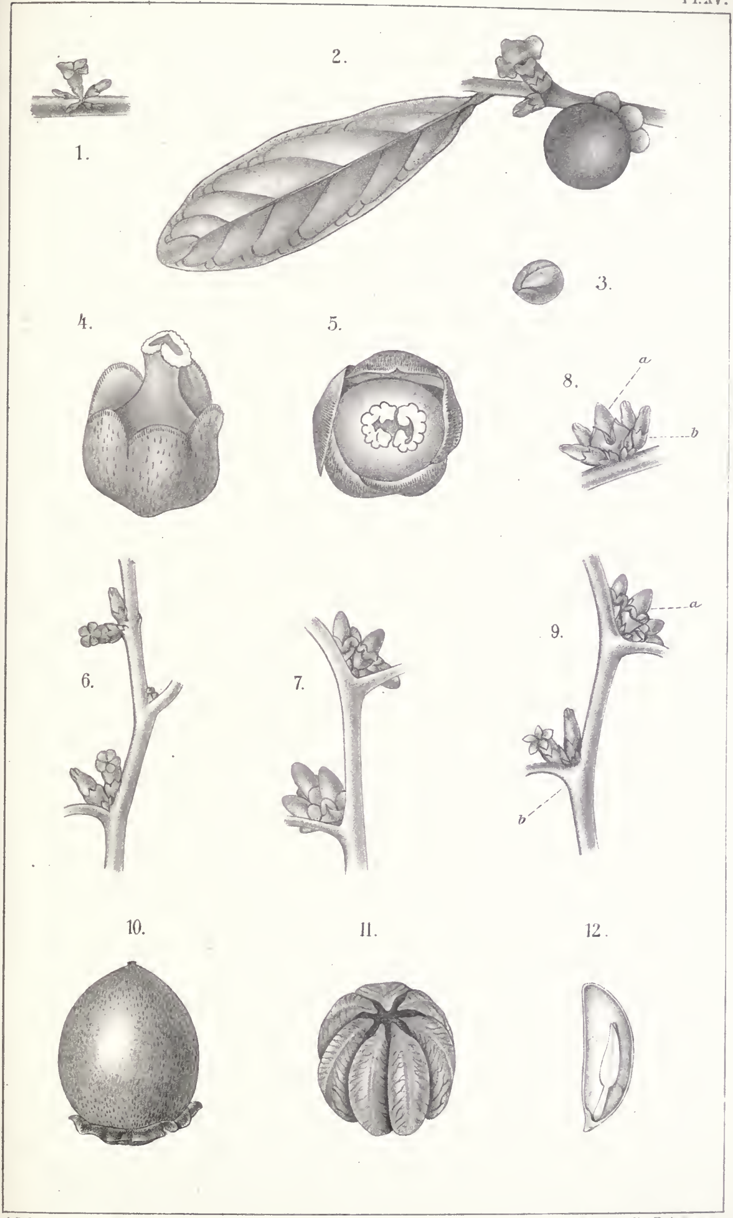


W. de Alwis et H. W. del. Lith Anst. v. F. A. Funke, Leipzig.

D. EBENUM. (1-8), D. PRURIENS (9-12).



D. INSIGNIS (1-5). . D. MOONII (6-10).



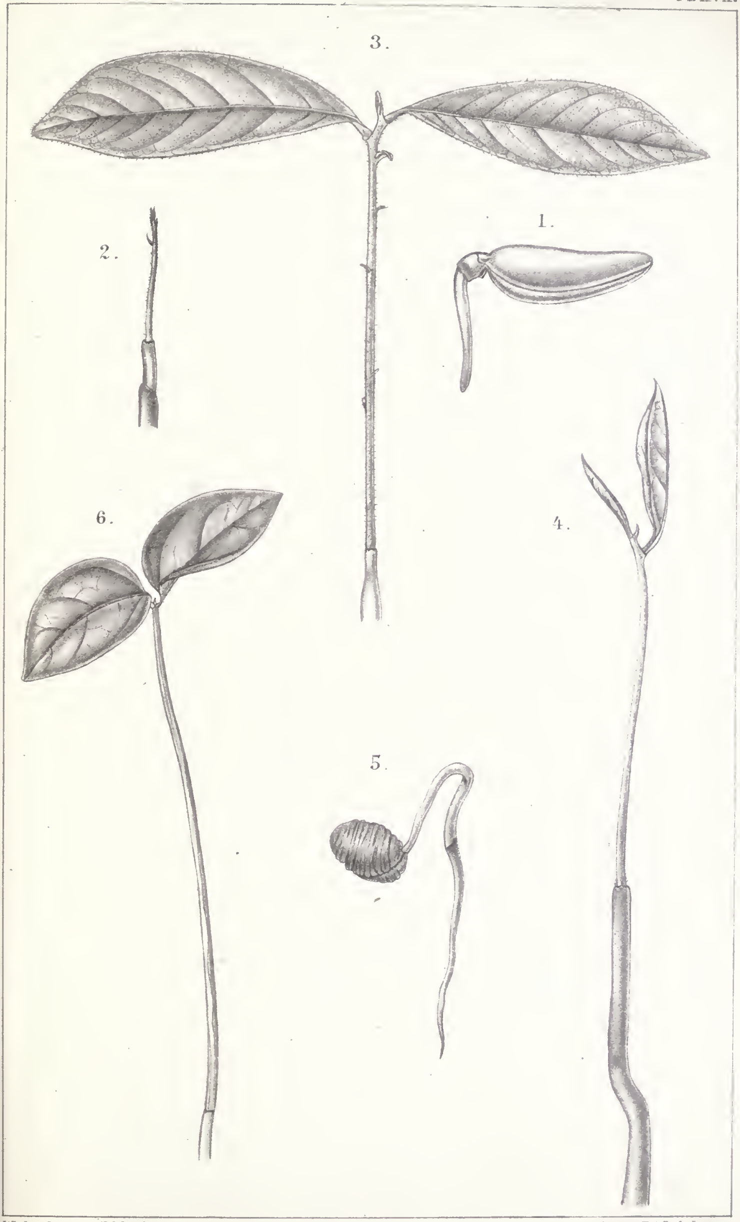
G. de Alwis et H. W. del. Lith Anst. v E. A. Funke Leipzig

D. OVALIFOLIA (1-5). D. HIRSUTA (6-12).

W. de Alwis et H. W. del.

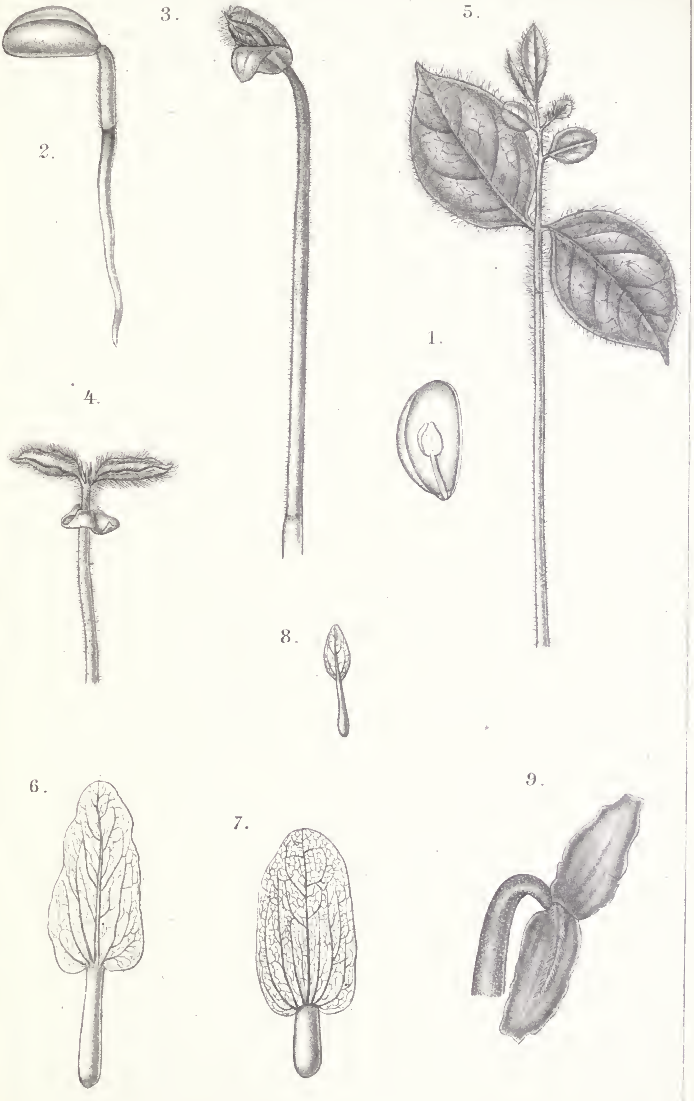
Lith. Anst. v. E. A. Funke, Leipzig.

D. THWAITESII (1-6), D. MONTANA (7-10).



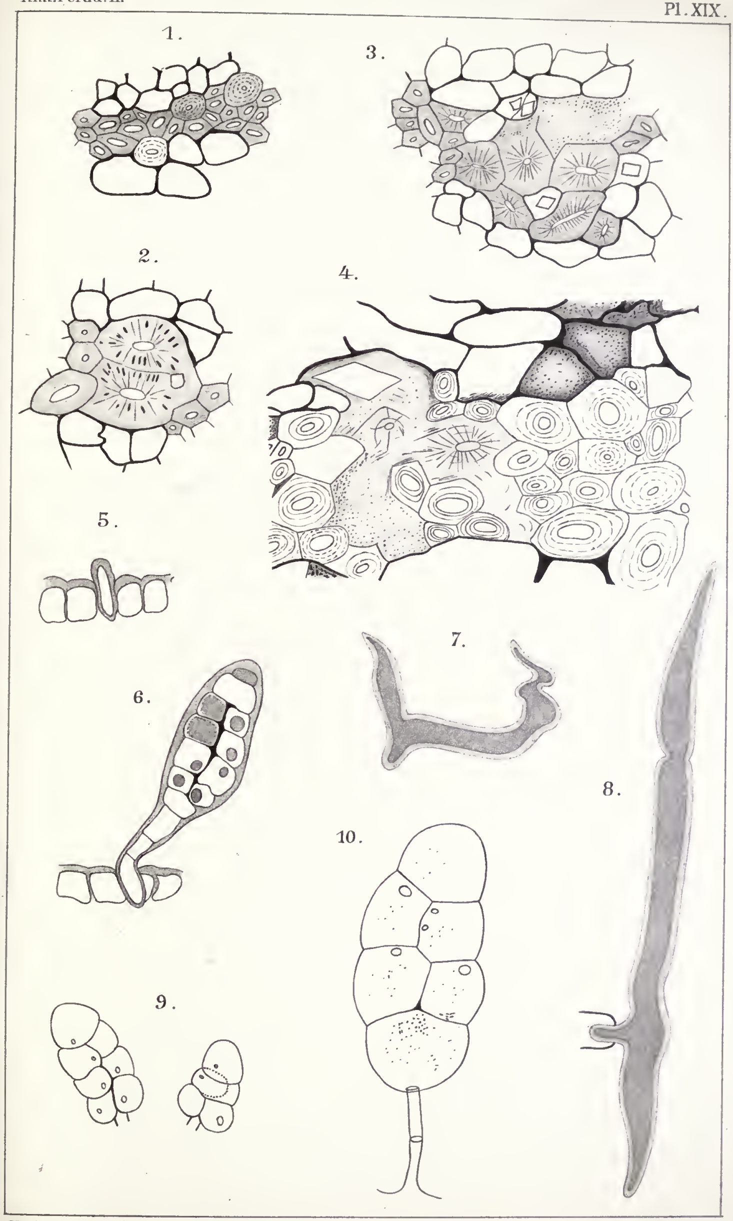
W. de Alwis et H. W. del. Lith Anst. v. E. A. Funke, Leipzig

D. INSIGNIS (1-3), D. TOPOSIA (4), D. SYLVATICA (5-6).



W. de Alwis et H.W. del. Lith. Anst. v. E. A. Funke, Leipzig

D. PRURIENS (1-5), D. CRUMENATA (6), D. EMBRYOPTERIS (7-9), D. EBENUM (8).



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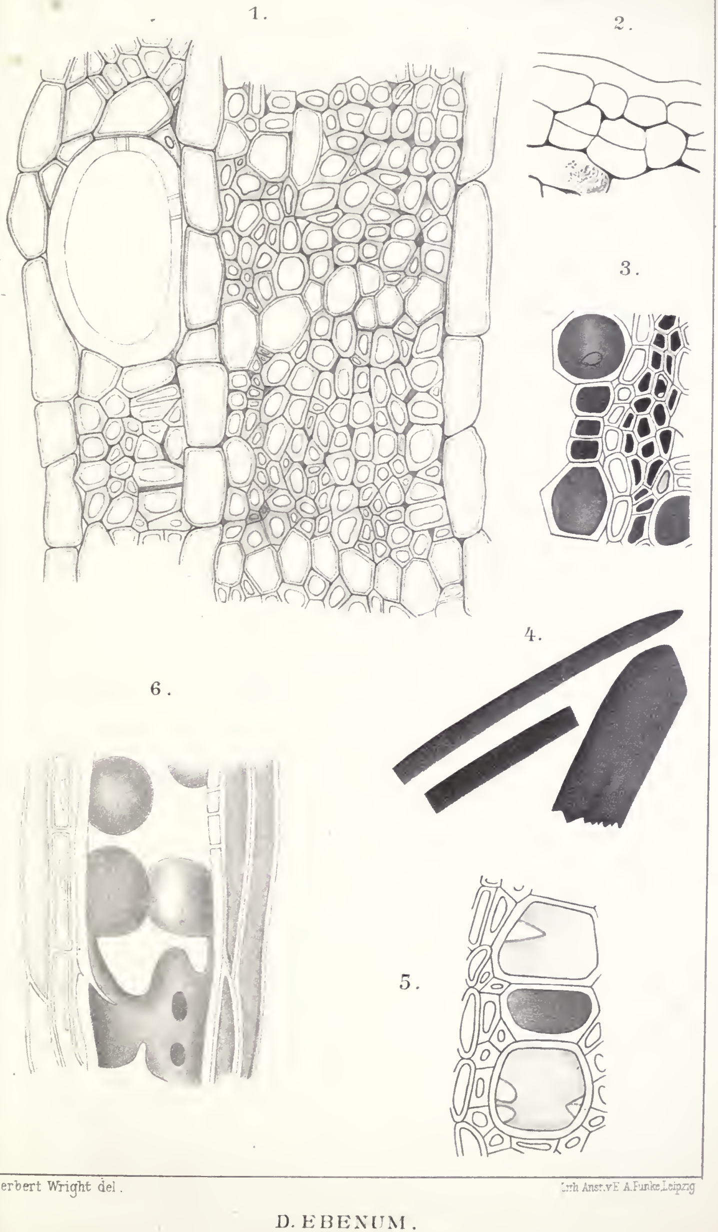
D. EBENUM.



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D. EBENUM.